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COURTESY COLORADO ASSOCIATION A PAUSE AMONG THE ASPENS

Ingersoll-Rand *presents*

TWO-STAGE AIR-COOLED PORTABLE COMPRESSORS

As It Seems To Us

A HUGE BUSINESS

THE greatest individual commercial enterprise in the United States is the Post Office Department. No other organization does business with so many people, and none can match the range of its activities. We take its work for granted; and because it is operated at a deficit we are prone to be overcritical of it. Candor compels the admission, however, that our money buys more service, dollar for dollar, at the post office than anywhere else. Whether we write one letter a year or one million, we obtain the same price and the same service. There is no discriminating between customers. Our mail comes to us regularly and punctually if we are in the heart of Manhattan or on a desert homestead. The percentage of errors in the handling of mail is incredibly small, and delays are so exceptional as to be classed as rare. We drop a letter in a mail box with a feeling of security: we fairly know that it will reach its destination.

In normal times 250,000 persons are employed full time in the post-office organization. Several thousand more perform contractual labor or receive part-time or indirect work. Compared with 1908, each postal employee's efficiency had increased nearly 72 per cent by 1931—that is, the output of ten men then equaled that of seventeen men 23 years previously. This was due to better organization, to the use of more mechanical equipment, and to the speeding up of the human element, itself. This gain in per-man output was accomplished in the face of a vast extension of service, both as to quantity and range. Parcel post, air mail, and postal savings were some of the major additions during that period, and rural facilities were greatly improved and increased. There is something remarkable about being able to obtain essentially the same postal service in a remote town of 5,000 population as in Washington, itself. No privately owned business offers us comparable facilities when buying from it.

The inside of a large post office today has some of the aspects of a factory. Mechanical conveyors, pneumatic tubes, floor trucks, ingenious canceling machines, and other work-speeding agencies are there. As new buildings are erected, they are planned to expedite the manifold operations, and a rise in per-man efficiency results. Old-style interior architecture, with its massive columns, is ill-fitted to the work of the modern post office. Such buildings were constructed to be imposing to the eye. Today the inside of a post office is laid out with a view to convenience, to performing essential tasks speedily and economically. They are often as justified because of the savings they effect as is a new and more efficient factory building or a railroad cutoff or a paved main street.

OUR COVER PICTURE

THE San Miguel Mountains in Southwestern Colorado are among the most rugged in the state, but in places their austerity is tempered by heavy growths of conifers and quaking aspens, with wild-flower gardens at their bases. This view, from a photograph by H. L. Standley, shows a group of members of the Colorado Mountain Club in one of these forested glens while on their way to climb Mt. Wilson.

THE ROCK DRILL AND JOBS

AT the risk of seeming archaic by even mentioning technocracy at a time when the average person has become sated with discussion of it, we present a reader's reflections upon the relationship between the rock drill and employment. Likening the ramified effects upon the demand for labor which result from the development of machinery to the ever-widening wave that is created by a stone thrown into quiet water, our correspondent writes:

"In 1866, BROOKS, GATES, and BURLEIGH built power drills for the Hoosac Tunnel in Massachusetts that combined and improved upon the earlier inventions of J. J. COUCH and J. W. FOWLER. The drills broke easily, and CHARLES BURLEIGH brought forth a new design which proved fairly satisfactory. This machine and the SIMON INGERSOLL drill that appeared in 1871 were the first real body blows to hand drilling. Their immediate effect was to revolutionize mining, as they so far reduced drilling costs as to make profitable the recovery of relatively low-grade ores. Mines became far more numerous, and with them came the need for power plants and extensive machinery installations. The experience gained in mining brought further improvements in excavating equipment and eventually made possible works of great magnitude such as the Panama Canal, the New York subways and subaqueous tunnels, and, latterly, the Hoover Dam. Directly and in directly they afford work for thousands of men."

Dozens of other pneumatic tools sprang from the rock drill, and all of them have furthered industry, transportation, and other lines of endeavor which are large employers of labor. "So," concludes our contributor, "the wave created by the invention of the rock drill has been traveling farther and farther, creating additional markets for labor and extending into more and more fields."

HOUSES OF THE FUTURE

BUILDING a new house in the future may become a matter of reading catalogues rather than of calling in architects and artisans. Such a house will be fireproof, virtually weatherproof, will never require repainting, and will be erected complete in fifteen days or less. The component materials, partly assembled, will be shipped from factories with every piece marked for its position, and only a small portion of the total labor represented will be applied at the site.

A specimen dwelling of this type is under construction at Cleveland, Ohio, through the joint efforts of the American Rolling Mill Company and the Westinghouse Electric & Manufacturing Company. It was designed by MILLS G. CLARK, president of Insulated Steel, Inc. It is asserted that, by virtue of the innovations and improvements it embodies, the average American family will be able to own a more modern and a more comfortable home than that now occupied by the typical prosperous businessman.

This unique house will have walls of rust-proofed, welded, corrugated steel, which will be shipped in sections convenient for handling and for arc-welding at the building site. The exterior will be of Celotex, overlaid with colored porcelain-enamel shingles which are fire and weather resistant and which will never require refinishing. Between the exterior and interior walls will be an insulating air space that is calculated to reduce fuel bills. Gypsum wall-board and plaster will form the interior walls, with baseboards of Micarta, a material which will not scratch and which is unaffected by water. Floor supports will be of steel. Beneath the laminated hardwood covering will be a layer of mastic to deaden sound. Ceilings will be of acoustical tile. Bathroom walls will be finished in Micarta tiling. Door and window frames will be of metal. Shingles, Celotex, and other materials will be fastened to the steel framework with screwlike nails.

By blowing tempered air into the honeycomb spaces of walls and floors, it will be possible to control the house temperature in either summer or winter. There will be no screen doors. The glass in the outer doors will be movable up or down, much as that in automobile doors is now maneuvered. When a panel is lowered, a rolled screen attached to the upper edge of the glass will unreel and cover the opening. An all-electric kitchen will be provided, and various other uses will be made of electrically operated appliances. Small circuit breakers will replace fuses, protecting the wiring against overloading and overheating.

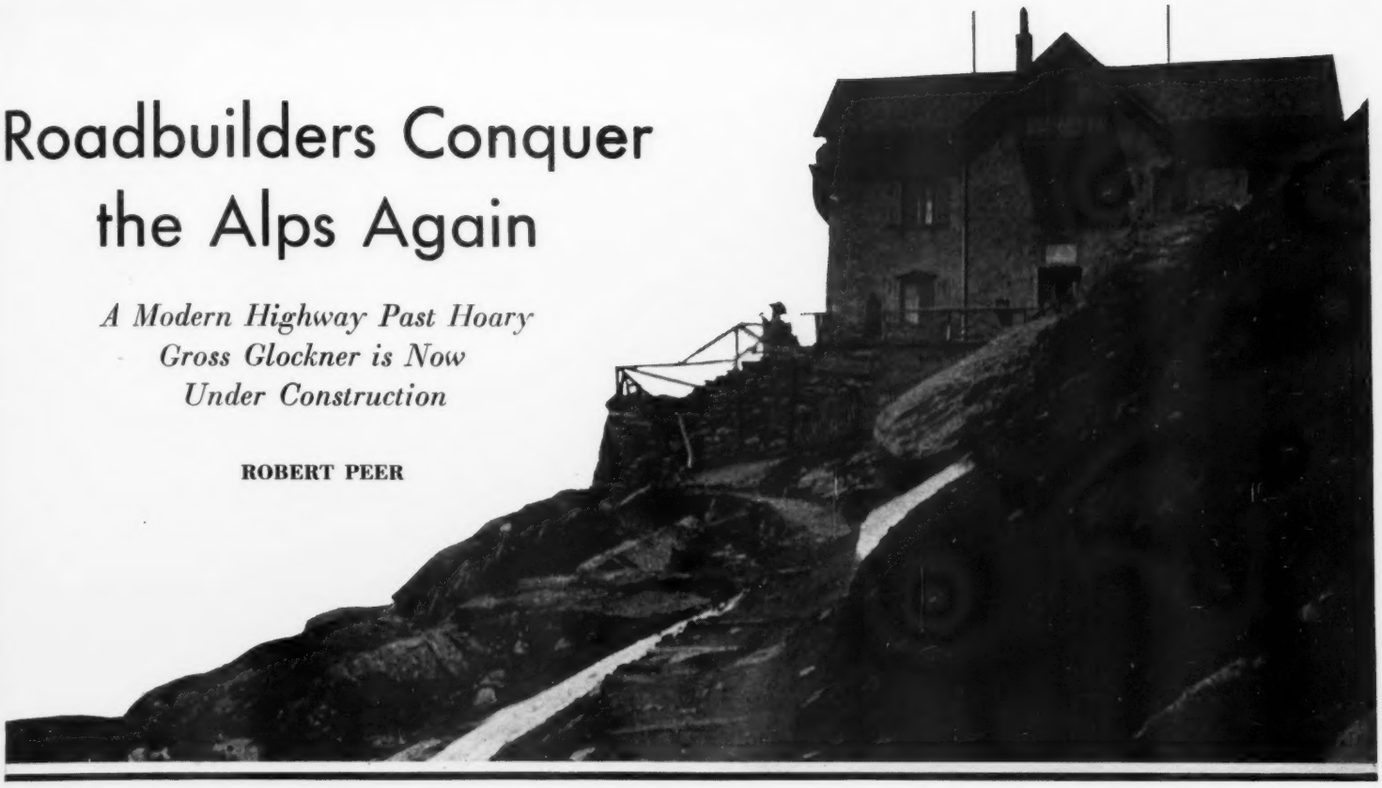
Such is the promise held forth to us. It is claimed that such houses will cost less than we now pay for homes of comparable sizes and comforts.

Picturesque Heiligenblut at the foot of the Gross Glockner.

Roadbuilders Conquer the Alps Again

A Modern Highway Past Hoary Gross Glockner is Now Under Construction

ROBERT PEER



Where the lookout or branch road comes to an end. Shelter house for tourists at Franz Josefshoehe.

THE conquest of the Alps by the trail blazer is an interesting story that goes back to the third century before Christ when Hannibal, that great Carthaginian general and statesman, accomplished the seemingly impossible feat of crossing the Alps with a military force of 90,000 infantrymen, 12,000 horsemen, and 37 elephants. That perilous march from France into Italy is said to have cost Hannibal half his troops; but it has gone down in history as one of the most memorable military achievements of ancient times. Just what route he followed is subject matter for debate; but the weight of evidence seems to point to Mont Genêvre Pass which reaches an altitude of 6,083 feet.

Centuries later the Romans opened up mule trails in several of the passes leading into France and Germany. They were probably the pioneers in this work of roadbuilding in the Alps; and there are in existence today Roman maps, made during the third century after Christ, on which such mountain paths are indicated. Of some of these all traces have been lost—time has obliterated them; and others have undergone such changes that they are hardly recognizable. Though travel over those trails was exceedingly hazardous for both man and beast, they remained substantially unchanged until the early part of the eighteenth century.

In those days there were only a few passable trade routes over the main ridge of the Alps, and these connected Germany, to the north, and southeastern France and what is now Italy lying to the south. The entire central chain, extending for a distance of almost 310 miles, was devoid of anything that could be termed a road; and attempts to negotiate its various passes by wagon or coach were attended with the greatest difficulties, hardships, and dangers. Sooner or later obstacles were encountered; and, if nothing worse happened, the vehicles had to be taken apart and packed on the backs of the draft animals. It meant traveling most of the way on foot.

Warfare rather than peaceful pursuits seems to have prompted the blazing of those early lines of communication over Europe's highest and mightiest mountain range that stretches for a distance of 621 miles from southeastern France through Switzerland and Austria into Hungary. Napoleon, like his illustrious predecessors, Hannibal and Julius Caesar, was not dismayed by that rocky barrier, for early in May of 1800 his armies marched across the Alps by way of the Great St. Bernard Pass. He realized the strategic and commercial importance of these Alpine highways; and under his regime were improved and constructed seven military roads and carriageways connecting France with Italy.

After the fall of the first French Empire, roadbuilding in the central and eastern part of the Alps was actively undertaken not only by France but also by Switzerland and Austria-Hungary. Then it was that the carriageways came into being that are to this day the principal routes of travel in that region. Of these the best known are those that traverse the Little and the Great St. Bernard passes, 7,237 and 8,111 feet high, respectively; the Bernina Pass, 7,670 feet; the St. Gotthard Pass, 6,936 feet; and the Stilfser Joch, 9,130 feet above sea level.

The railroad builder logically followed the roadbuilder; but not until the middle of the nineteenth century when the mountain paths were no longer adequate—could not meet the ever-increasing demands of traffic. The Semmering Railway was the first to cross the Alps, and it considerably shortened the distance between Vienna and Trieste. Construction on this project was started in 1850, and the line was put in operation four years later. Then came the Brenner railroad, in 1867; the Mont Cenis, in 1871; the St. Gotthard, in 1881; and the Arlberg, in 1884. With the advent of the "iron horse," traffic on the carriageways began to decline, especially on those in the sections which were being served by the railways.

For years prior to the World War, horse-drawn mail and passenger coaches were about the only vehicles to make use of the Alpine roads. But this is all changed now: the automobile has brought them again into their own. Today, some of the old mule and wagon trails are fine, well-kept highways over which hundreds of thousands of motor cars and buses pass annually. Contrasted with the conveyances of the years gone, they experience little difficulty in negotiating the steep grades, and they carry the traveling and sight-seeing public with comparative speed and comfort up into the regions of perpetual ice and snow.

Just what changes have been effected through modern highways and means of transportation in certain sections of the Alps is strikingly brought out by the fact that the world-famed hospice in the Great St. Bernard Pass is to be abandoned for a new site where there is work to do. Since 962 that monastery has stood guard on the Italian-Swiss frontier, carrying on its humane service of suc-

Right—Tourist hotel in the Village of Ferleiten, which was the northern terminus of the old roadway.

Below—Toll gate at the northern end of the Gross Glockner Highway.

coring exhausted and stray wayfarers. How many lives have been saved by the monks and their St. Bernard dogs is not known. When asked the question, the answer has been: "We have aided all we could and whenever we could." The new hospice is to be situated in the Si-La Pass in the Himalayas at the southern boundary of Tibet. This pass lies 13,780 feet above sea level—more than 5,500 feet higher than the Great St. Bernard Pass, and is traversed annually by thousands of pilgrims and traders bound, respectively, to the Tibetan shrines and the markets in the Indian plains. Here, where hundreds have perished each year in the ice and snow, the merciful Augustinians will continue the work of rescue that was begun by St. Bernard de Menthon so many centuries ago.

West of the Brenner Pass the Alps can be crossed at fairly numerous points—that is, the passes embraced within that area and now open to traffic are not more than 50 miles apart as the crow flies. This is not true of the stretch that extends through Austria. There no through roads are to be found for distances of 100 miles. This involves the making of lengthy detours, and is proving a handicap especially to the motorists on opposite sides of the mountain barrier. The question of providing adequate means of intercommunication somewhere between Brenner Pass and Tauern Pass—the section concerned—has been under consideration for a long time. Originally it was planned to construct a railway from Bruck, in the Province of Salzburg, to the Gross Glockner, towering 12,461 feet above sea level; and in 1890 preliminary work was started on a cogwheel railway to the Franz Josefshoehe. This project, however, was abandoned, and the entire proposition held in abeyance.

In 1924, Oberbaurat F. Wallack initiated operations on a short stretch of road across the main ridge of the Alps at the Gross Glockner so as to connect two existing roads terminating close to the crest and approaching from opposite directions. Thus was provided without much difficulty a through route from Zell am See via Bruck, Fusch, and Ferleiten, in the Province of Salzburg, north of the range, to Heiligenblut, in the Province of Carinthia, lying to the south. Because of this link the distance between the two valleys was shortened by 96.5 miles, in other words, from 158.5 to 62 miles.

Six years later, in 1930, the Austrian Government decided to undertake the construction of a new and wider road, in the same general neighborhood, that would be up to date in every respect and in keeping with the ever-increasing demands of automobile and tourist traffic. This highway was to be known as the Grossglockner-Hochalpenstrasse. A committee for the building of the Grossglockner-Hochalpenstrasse was promptly formed, and got the preliminaries well underway before operations were transferred to the Grossglockner-Hochalpenstrasse Joint Stock Company, which is now completing the work.

The total cost of the project is estimated at 12,000,000 Austrian Schillings, approximately $1,700,000 in United States currency, of which 60 per cent is guaranteed by the

Rolling a finished stretch of the Grossglockner-Hochalpenstrasse just outside the Village of Heiligenblut.

Left—The upper reaches of the Gross Glockner group, showing the winding course followed by the road.

Below—One of the DU air-operated hoists employed in switching service.

Austrian Government; 30 per cent by the Allgemeine Elektrizitaets Gesellschaft, which is interested in the projected Tauern hydro-electric undertaking; and the remainder is being raised by the local governments of the Austrian provinces of Salzburg and Carinthia and by other lesser interests. On the basis of the negotiations with the representatives of the Austrian ministries of Finance, Commerce and Traffic, Agriculture, Forestry, etc., the contract for the work was given to two groups of contractors. The first is composed of Redlich & Berger; Vianova; and the Allgemeine Baugesellschaft Porr. In the second group are: Ing. Spritzer A.G. fuer Bauwesen; Prokop, Lutz & Wallner; Polenski & Zoellner; and Ing. Arnoldi. On August 30, 1930, in the presence of the Austrian Minister of Finance and the President of the Province of Salzburg, the first shot was fired that signaled the beginning of operations.

To the north, the Grossglockner Highway joins the existing road in the Village of Fusch, which is situated about 62 miles below Salzburg. Thence it leads south through Ferleiten and, after following a fairly winding course, reaches the main ridge of the mountains at an altitude of 8,225 feet. The highest point in the road will, therefore, be 1,289 feet above the crest of the St. Gotthard Highway in Switzerland, which is 6,936 feet above sea level. At the summit, the new roadway will be carried through a tunnel some hundreds of feet long, and thence will lead down to Heiligenblut, a picturesque Alpine village snuggling close to the foot of the Gross Glockner. Heiligenblut is much frequented by tourists during the summer months, and is the starting point for high-mountain tours.

The Grossglockner-Hochalpenstrasse will follow fairly closely a trail blazed hundreds of years ago by the Romans, and of which evidences in the shape of cart-wheel tracks in the rock formation are still visible. It will pass by old walls and galleries—the remains of gold and silver mines that were worked in the fifteenth century. Some of the place names in the region are indicative of the fact that mining operations were once carried on there; and who knows but that better means of transportation may again revive that industry which, we are told, flourished in those mountains in the decades gone.

In addition to the main highway, the plans call for the building of a secondary or look-out road, which is so called because it will afford magnificent vistas of the surroundings. This road will have a length of about 5.5 miles. It will branch from the Grossglockner-Hochalpenstrasse on the southern side of the ridge at an altitude of 6,276 feet and, after passing the Glocknerhaus, where tourists may find shelter, lead to the Franz Josefshoehe which is 7,746 feet above sea level. From this eminence, the sight-seer commands an imposing view of the entire Gross Glockner group and of the Pasterzen Glacier which covers an area of approximately 11.5 square miles. This is the largest glacier in the eastern Alps.

The Grossglockner Highway will be about 23.5 miles long and surfaced with macadam. With the exception of the cuts, where it will be 18.5 feet wide, the road will have a general

Carving a pathway along the mountainsides with the aid of rock drills and portable compressors.

Ingersoll-Rand "Jackhamers" are being employed extensively for the drilling of blast holes.

Another one of the portable compressors of which there are fourteen on the job.

This portable has been used for high-altitude work since 1923 and is still going strong.

width of 19.7 feet and will accommodate two lanes of traffic. At the curves, which will have a radius of 26.25 to 32.8 feet, it will be widened out to as much as 36 feet. The grades, for the most part, will range from 9 to 10 per cent, with a maximum not exceeding 12 per cent. These should present no difficulties to high-powered cars.

In all respects, the Grossglockner-Hochalpenstrasse will compare favorably with, in fact surpass, the most-frequented of the north-and-south highways across the Alps. Those for instance that traverse the Brenner Pass, the Stilfser Joch, and the St. Gotthard Pass have a width of only 16.5 feet, while still others, on which passenger car and bus traffic is equally heavy throughout the summer months, are, for long stretches at a time, but 11.5 feet wide, thus making them hardly more than one-way lanes. As for the matter of curves, it may be pointed out that those in the St. Gotthard and Simplon roads have a radius of 16.5 feet while those in the Stilfser Joch Road are even sharper, varying from 13 to about 15 feet. The grades, too, are steeper, and range all the way from 15 per cent in the case of the Brenner Pass, Arlberg Pass, and Maloja Pass highways to 18 per cent for the Julier Pass Road, and 28 per cent for the Katschberg.

The rock formation encountered along the right of way consists partly of limestone and partly of serpentine and quartzite. Of these only the latter, because of its extreme hardness, has been difficult to penetrate in putting down the blast holes. Numerous "Jackhamers" are being used to do the drilling, and these are being supplied with air by fourteen Ingersoll-Rand compressors of different types and sizes. Some of these machines are not new to the work; but all of them are proving highly reliable and efficient although operating at times under adverse conditions at altitudes of more than 6,560 feet. The drill steels are being kept in condition by three No. 34 pneumatic sharpeners; and several air hoists of the DU type are on the job and doing much helpful work in a number of directions. It might be added that the contractors, because of the existence of the old road, experienced little difficulty in getting their equipment up to the higher levels.

Up to October 1, 1931, a total of 401,536 cubic yards of earth and rock had been excavated. This consisted of what has been classified as 121,638 cubic yards of hard rock, 188,343 cubic yards of medium earth, and 91,555 cubic yards of light earth. Up to that date, 85,016 cubic yards of rock had been used in the building of retaining walls, and 78,476 in making the road bed—163,492 cubic yards in all. A comparison of these figures will show that the amount of rock removed was not sufficient to meet the requirements, and it was therefore necessary to open up a number of quarries—in fact, eight. Three of these, two lime-slate and one quartzite quarry, are located in the northern half of the project and the others, two serpentine and three lime-slate, in the southern half.

At numerous points throughout its course the roadway has to be carried over depressions and ravines, necessitating the building of bridges. These, depending upon circumstances, are being constructed of concrete or in the form of stone arches having spans of from 6.5 to 33 feet. On account of the great heights at which much of the work is being done, and because of the unfavorable conditions that prevail there during many months of the year, the building season is a limited one, extending from May to October in the case of operations at altitudes up to 6,560 feet and only from June to October for those beyond that point.

The first stretch of the road was opened to traffic in the summer of 1931, and extended for a distance of 4.25 miles from Fusch to Ferleiten, north of the mountains. During 1932, fifteen miles were finished—five more on the north and ten on the south side, making a total of 19.25 miles or 66 per cent of the entire project, which is scheduled for completion this year but probably too late for the peak of the tourist season.

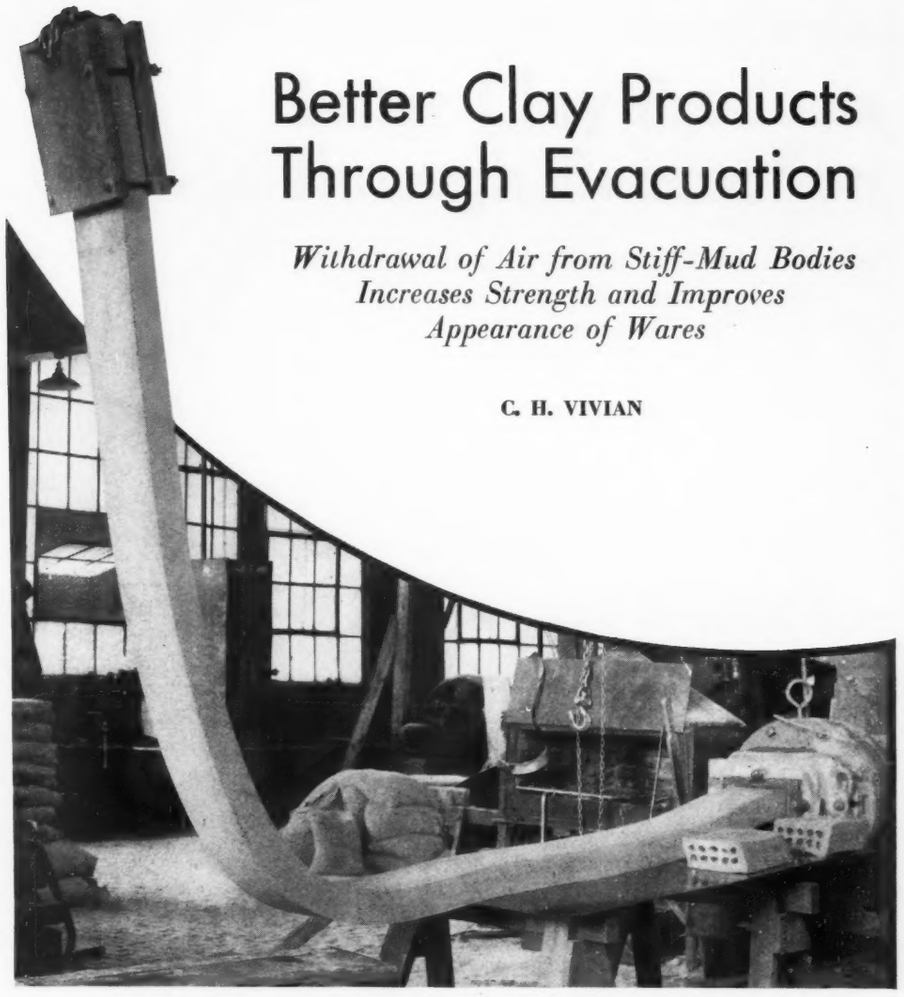
From an engineering standpoint, the Grossglockner-Hochalpenstrasse will be the finest example of highway building in the Alps. This is understandable, as most of the other routes across the mountains were constructed at a time when the roadbuilder was not so well equipped for the work as he is today. The new thoroughfare will be a scenic route from end to end—from the pleasing valleys on up to the towering and awe-inspiring heights of the Gross Glockner group. Aside from the attraction it will offer the sight-seer, the road will put within easier reach of the motoring public approaching from the south such spas and places of interest as Salzburg, Zell am See, Kitzbuehel, Berchtesgaden, Koenigsee, Reichenhall, and Badgastein, and to those coming from the north the equally well-known summer resorts of Heiligenblut, Klagenfurt, Woerthersee, Millstaedter See, Bozen, and Meran.

Toll gates are being erected at both ends of the line; but only automobiles are expected to pay the fees which, it is believed, will be sufficient to cover the amortization and upkeep costs. The Grossglockner-Hochalpenstrasse Joint Stock Company has based its calculations on 120,000 foreign visitors annually—a figure that it has every reason to believe will be exceeded because of the steady increase during the past few years in international tourist traffic. It might be added in conclusion that by giving part-time work to several thousand men for a number of years, this important roadbuilding project has been the means of alleviating to some extent the unemployment situation in Austria.

Better Clay Products Through Evacuation

Withdrawal of Air from Stiff-Mud Bodies Increases Strength and Improves Appearance of Wares

C. H. VIVIAN



Courtesy, Brick & Clay Record

This column of stiff-mud clay from which the air has been removed was extruded from a brick machine to a length of 27 feet without breaking. When unevacuated, the same clay broke off in lengths averaging only 14 inches. When supported at a point 5 feet away from the extrusion die, the column here shown withstood the weight of a 250-pound man for a period of several seconds before giving way.

THE phenomenon of suction has been made much use of in domestic and industrial fields in recent years. Our homes are kept clean with vacuum apparatus. Our radio receiving sets depend upon vacuum tubes for proper functioning. We consume coffee, corn, and sundry other food products that owe some of their natural taste to having been packed under vacuum. In industrial plants, vacuum is equally important. Steam is made to perform more work by causing it to expand below atmospheric pressure in turbines and engines. In countless processing plants, of which sugar mills are an example, evaporation of solutions is effected by the aid of vacuums. A long list of other uses might be made.

One of the more recent commercial applications of vacuum is in the removal of air from stiff-mud clays prior to forming them into brick, tile, and other products. Although the process is still in its infancy, it has already been put to use by two potteries in the making of the more delicate ceramic products such as whiteware.

The customary procedure in manufacturing stiff-mud ware is to grind the clay; add enough water to give it the desired consistency; knead it thoroughly in a mechanical device known as a pug mill; and, finally, to force it, by means of a screw conveyor akin to that in a household meat grinder, through dies of suitable size and shape. This extruded column is then cut into uniform segments. The clay bodies thus formed are, of course, dried and next fired to impart the prescribed color and hardness.

The extensive working of the clay mass naturally tends to give it a laminated structure, and the existence of air between the layers exaggerates this condition. Air is also distributed in voids throughout the mass without regard to continuous planes and has the effect of interrupting its continuity and of creating voids, cavities, or blisters in the finished product. These and other deleterious influences of air have long been recognized; and it is suspected that air is also responsible for certain additional disadvantages. Research has now proved that the deaëration of clays has numerous beneficial effects and practically no injurious ones. Several makers of clay-working machinery have individually investigated the subject, and in recent months extensive tests have been made at the Engineering Experiment Station of Ohio State University in coöperation with The Bonnot Company of Canton, Ohio.

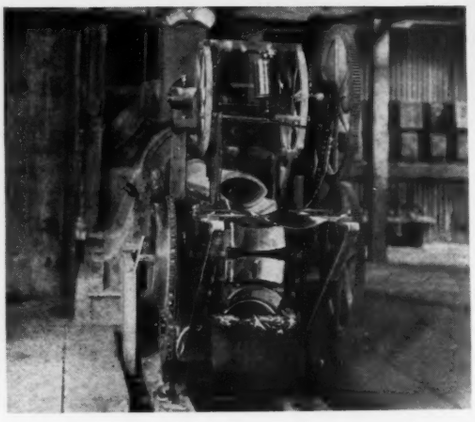
There are three ways in which air can be removed from clays: by literally squeezing it out by applying pressure repeatedly, by employing vacuum pumps, and by replacing it with a gas that will later either be condensed under pressure, dissolved by water in the mass, or absorbed by the particles of clay. The pressure method has been used commercially in the formation of pressed brick. The evacuation method seems most suitable for treating stiff-mud bodies, and it is to this that commercial plants are now turning.

Experiments in clay deaëration were started more than 30 years ago. In 1902, a patent on such a process was granted Raleigh H. Staley. This was assigned to Chambers Brothers Company of Philadelphia, Pa., and became the basis for a machine which, in improved form, is now being offered the trade. The Bonnot Company has likewise developed suitable equipment and has received patents on it. In this work the firm has been aided by Davis Brown, a consulting engineer of Los Angeles, Calif., who has had a prominent part in setting up several successful commercial installations on the Pacific Coast. More will be said of these later after we have considered some of the benefits of air removal, as determined in the experiments conducted at Ohio State University.

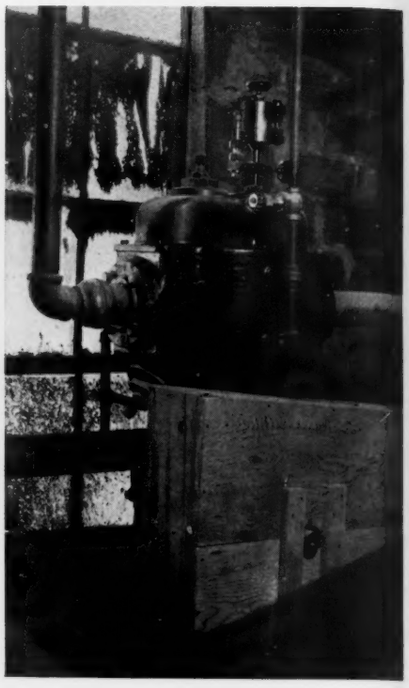
Ten clays, differing widely in character but all used by plants employing the stiff-mud process of manufacture, were given a wide range of tests in which normal and evacuated specimens were compared. The results were uniformly favorable to deaëration. One of the most pronounced effects noted was the improvement in workability. Evacuation made the highly plastic clays easier to handle, and it rendered those of low plasticity comparable in workability to superior clays under normal, established processes. The results indicate that lean clays can be used to greater extent than ever before and that evacuation will eliminate the need of adding specific ingredients to many clays to render them more workable. The latter betterment promises to remedy many die troubles and to permit the making of shapes and sizes which have previously been considered impossible.

The extraction of air from clays increases

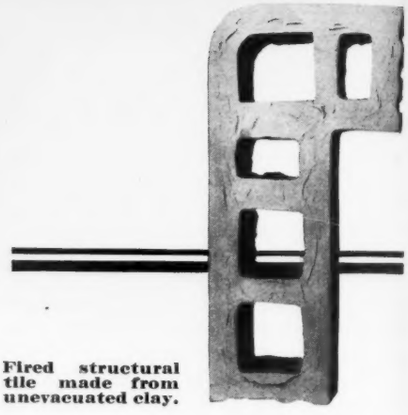
The buildings shown above are roofed with Cotswold tile made by the evacuation process.



Right—A roofing-tile machine in one of the Pacific Coast plants of Gladding-McBean & Company.



Upper right—Type 15 vacuum pump which serves the roofing-tile machine.



Fired structural tile made from unevacuated clay.

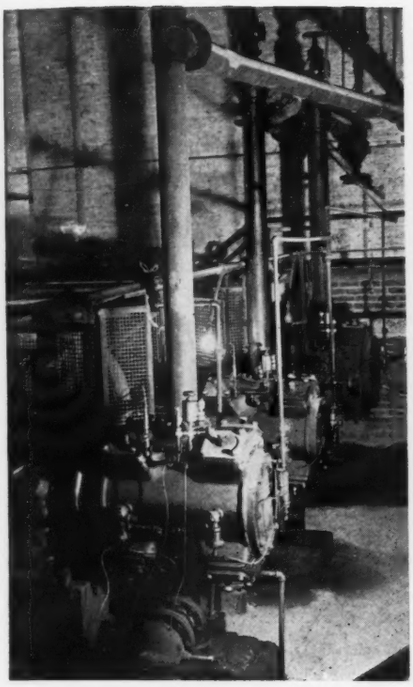
the weight of the finished article from 3 to 6 per cent. While an increase in weight is, in itself, of no especial value in most products, it means greater compactness, and this imparts desirable qualities. It is significant that while the increase in weight averages around 3 per cent the increase in strength averages 30 per cent. It is pointed out that the weight of hollow ware can be reduced by making its walls thinner.

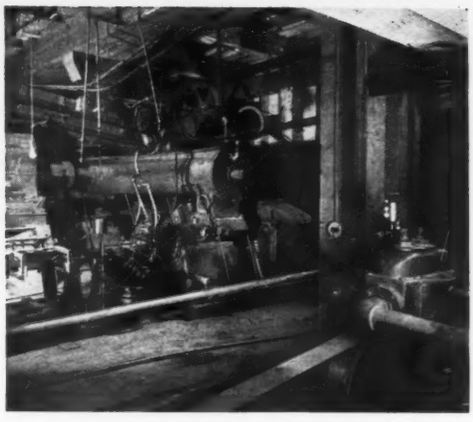
Evacuation improves the appearance of the product. The increase in plasticity results in smoother surfaces and sharper edges. Tears and deformations are less frequent. Blistering, which has long been a bugbear to manufacturers, seems to be eliminated by withdrawing the air. When fired specimens are broken in half, visible laminations are found to be greatly reduced; and in the cases of structural tile and paving brick they are entirely missing. Fewer laminations give the bodies a denser composition and probably account for their greater strength.

The increases in strength in the plastic stage resulting from evacuation are quite remarkable. One-inch square sections of evacuated and unevacuated clays were extruded from a die and allowed to project over the edge of a cutting table. The unevacuated column broke off under its own weight after reaching lengths of from 4.5 to 8.6 inches. Of eight specimens of evacuated clay tested all but two bent and touched the floor, 43 inches below, without breaking. Those two broke at 24 and 30 inches, respectively. The tensile strength of the stiff-mud column was shown to be increased from 29 to 140 per cent by evacuation. Evacuated samples withstood loads from 3.5 per cent to 75 per cent greater than unevacuated ones before being crushed One investigator dropped two balls of the same size from a height of 17 feet. The evacuated mass showed 62 per cent less deformation than the unevacuated one. When unevacuated clays were crushed they broke at the corners as soon as deformation began, and continued to rupture around the edges as the load was increased. Evacuated bodies "simply settled down and spread out without external rupture, very much the same as a mass of pitch or tar would when loaded under the same conditions." Greater strength means less breakage in handling.

Evacuated clays showed to advantage in the drying tests. One hundred and six specimens each of evacuated and unevacuated bodies were dried at temperatures of 392°, 527°, and 662° F. Forty-six of the unevacuated specimens cracked. Only sixteen of the evacuated specimens cracked, and nine of those were of one type of clay. The conclusions, as yet unconfirmed on a commercial basis, are that evacuation will permit the maintenance of faster drying schedules without an increase in loss, or that it will insure a smaller loss if prevailing schedules are followed. These tests were made on relatively small sections, and the results obtained cannot be assumed to be typical of what will happen with wares of larger sizes. Since the laboratory experiments were made, enough practical experience has been gained in actual clay-working plants to indicate that any clay that will dry safely when not de-aired will do so when it is evacuated. The difficulties that have arisen have all been in connection with attempts made with the aid of evacuation to work clays which were never successfully dried without that aid. Technologists of the industry are of the belief that these troubles will be solved after further experience.

Firing experiments divulged that, in general, evacuation makes it possible to produce a stronger and less absorbent ware by firing at the temperature ordinarily used, or to produce a ware having conventional strength and other properties by firing at a lower temperature than that ordinarily used. The latter practice would effect savings in fuel and other items. Only general conclusions can be drawn on this point, as there are limiting factors in the case of many products which





Above—Beautiful terra-cotta ware is featured in this salesroom display of Gladding-McBean & Company.

Left—Another type of clay extrusion machine and its vacuum pump, at lower right.

Upper left—These three compressors supply air for atomizing oil used in firing kilns.

Fired structural tile made from evacuated clay.

require specific heat treatment. For example, where color is a limiting factor, the ware must be fired to a temperature great enough to produce that color; and it was determined that that temperature is not changed by evacuation. Tests revealed that the crushing strength of fired clays was increased in every case by evacuation. These improvements ranged from 4.14 per cent to 33.61 per cent, and averaged 19.89 per cent.

The investigations indicated that, for the clays tested, the degree of vacuum that produces the maximum improvement in physical properties in the plastic, dried, and fired states ranges between 25 and 28 inches of mercury. In late types of machines, the vacuum is applied in an airtight chamber located a little back from the forming die. The screw, or auger, extends through the vacuum compartment, and the clay is evacuated as it travels to the die. The plastic clay forms air seals at the openings through which the auger passes, and this eliminates the necessity for stuffing boxes or corresponding devices. It is possible to equip most machines already in service with an evacuation chamber. The use of vacuum increases the size of a machine somewhat, but not enough to become objectionable. According to J. H. Chambers, president of Chambers Brothers Company, the vacuum compartment adds about 28 inches to the length of that concern's brick machine having a capacity of from 5,000 to 7,000 United States standard-size bricks per hour. Approximately 10 per cent more power is required to operate this type of machine, and an additional 5 hp. must be provided for driving the vacuum pump.

"Our initial interest in evacuation was to improve the quality of street paving brick," states Mr. Chambers, "and for this use we think there is no possible question of its merit. The brick has much greater strength and better wearing qualities, and the absorption is materially reduced. In what we term the rattler test, the loss has been reduced by about seven points, that is, a brick that prior to de-airing lost 22 points now loses 14.8 points. This is a very important gain."

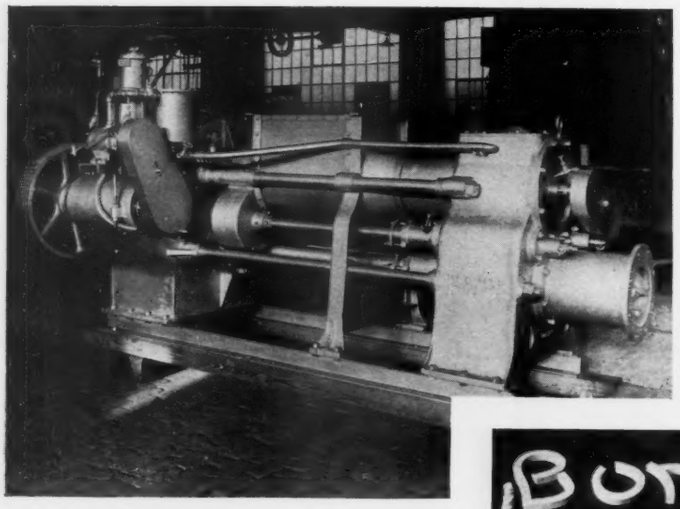
Mr. Chambers expresses the opinion that deaëration will effect a pronounced improvement in fire brick used for lining furnaces and fire boxes, but adds that where such brick is employed for insulating it will fulfill its purpose better if the clay is not deaërated. He sees no especial advantage in evacuating clays for ordinary building brick unless it is desired to use clays which lack sufficient strength when not so treated.

As was previously noted, Davis Brown has been a leader in researches with evacuated clays. He developed and patented a successful vacuum-mixing machine for making pipe, tile, brick, and kindred extruded products. From him Gladding-McBean & Company secured the rights to use the process on the Pacific Coast to make clay drainage pipe and sewer pipe. All other rights were assigned to The Bonnot Company.

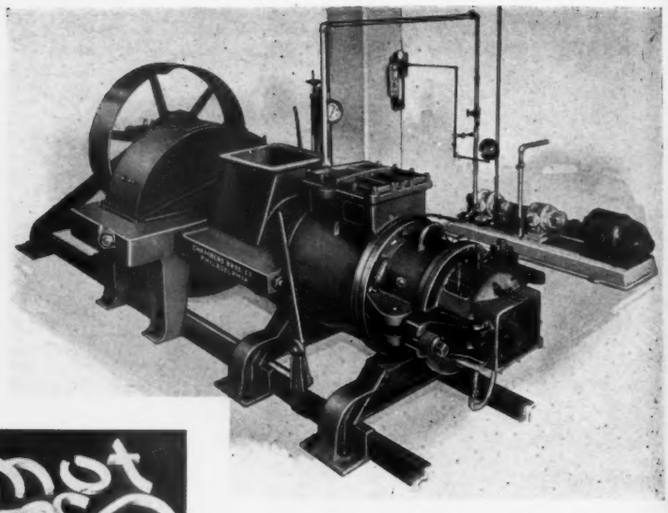
Gladding-McBean & Company made the first installation on the Pacific Coast at Glendale, Calif., under the supervision of Mr. Brown. This machine was later moved to Lincoln, Calif., and has been in operation there since. The same concern has another installation at Lincoln and one each at Renton, Wash., and Santa Monica, Calif. Various members of the company's staff have contributed to the successful application of the process.

As Gladding-McBean & Company is one of the pioneers in the commercial evacuation of clays, and as its operations are typical of well-run plants of similar character, we will present here a brief description of its activities at Lincoln, Calif., where its original vacuum-type machine is in use.

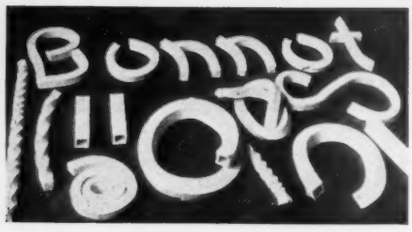
From two pits near the plant, clay is excavated and loaded into 5-ton dump cars by power shovels and draglines. Although to the layman it is all merely clay, there are really ten grades of it, each distinguishable



Latest type of de-airing extrusion machine made by The Bonnot Company.



Modern evacuating extrusion unit made by Chambers Brothers Company.



De-aired clay may be twisted into various shapes without breaking.

by the expert and having its own characteristics. Mining is confined to the summer season; and the clay is hauled over a narrow-gauge railroad to a large storage shed. This is essentially a huge roof supported by structural steel.

Clay of the desired grade is picked up from the storage piles by a clamshell bucket on an overhead traveling crane and deposited in chutes which feed a series of dry rolls. The ground material is elevated on belt conveyors to screens. The sifted clay, resembling flour, is stored in bins. The rejected material is returned to the rolls.

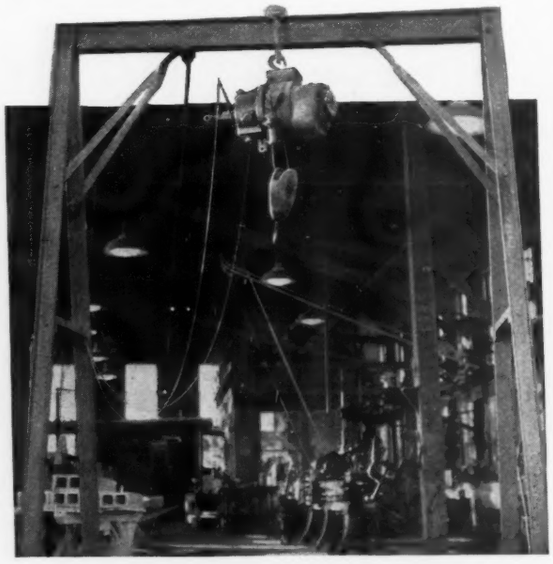
The ground clay is drawn from the bins into a multiple-compartment batch car. Somewhat as a cook or a druggist proportions ingredients to attain a desired result, the prescribed combination of clays for the particular product being made is metered into the car. This charge is transferred to a pug mill, where water is added and the doughlike mass is thoroughly kneaded and mixed much as bread dough is treated. The clay is here given what is referred to as its correct "temper," and this involves continual watchfulness and considerable skill. Peculiarities of the machine or machines to be used in each of the several processes of manufacture impose a variety of requirements which the plastic stock must meet.

Two types of machines are ordinarily used in turning out common shapes such as brick or tile. One depends upon steam or mechanical power to press the material into shape. The other is the vacuum-type apparatus with its worm feed that forces the clay through dies. The vacuum compartment is really a part of the kneading or mixing cylinder; and without recourse to vacuum the clay will go to the dies with a liberal infusion of air which affects the finished product very much as slag or other impurities affect metals in rolling or forging. Air pockets will cause laminations that can be compared to the fissures in steel rails which arise from imperfections. The clay is packed tightly in the revolving auger on either side of the vacuum chamber, and there is practically no leakage of air. A conventional gauge gives a visual check on the vacuum, which averages 27 inches in this plant. A belt-driven Ingersoll-Rand machine supplies the vacuum.

At the time it was observed, the machine was forming tile; and even a novice could readily distinguish between the ordinary and the deaërated product of the same machine. The evacuated tile has a much smoother finish; and time and wear serve to accentuate the contrast, as air voids may support very thin outer walls which fail later in service. Clays from which the air has been extracted emerge from the dies in more nearly perfect form, and there is less likelihood of their warping in the process of burning. Some economy results from the fewer pieces that have to be rejected. The chief object, however, is to enhance the beauty and utility of the product and to assure permanence of finish.

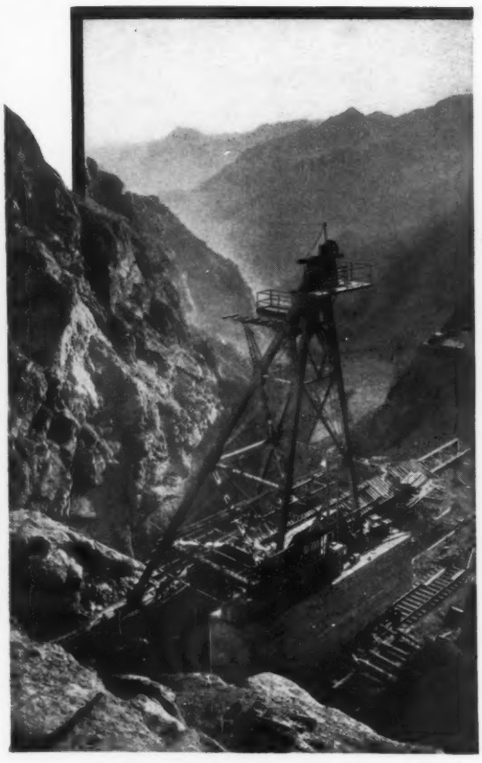
An interesting feature of the Lincoln plant is a large "tunnel kiln." Tile are loaded on special cars and pushed by an electrically controlled pusher through a series of separate kilns. Superior control of the firing process as well as more economical and more rapid production are obtained by this method.

All of the many forms of kilns in the extensive plant are oil fired. Air at 30 pounds pressure for atomizing the oil is supplied by three Ingersoll-Rand Class ER compressors. They have been installed as needed, and the older ones have been in service fifteen years. Another ER unit supplies high-pressure air to operate hoists and small tools, used in finishing terra cotta, and for miscellaneous other purposes around the plant. A Size C air hoist, mounted on a portable A-frame, is used for general service in the machine shop. Another hoist of the same size is mounted on an overhead track and used in handling large pieces of terra cotta in the dipping tank. The most interesting of the air-hoist applications is that on a revolving mast with an adjustable boom for stacking heavy tile and other products in large kilns.



The air-operated hoist proves helpful in many ways in the brick-plant machine shop.

The staff of the plant includes experts in manipulating the potter's wheel. Terra-cotta work of ornamental, highly artistic design requires modelers and expert architectural draftsmen. Artistic roof, floor, and wall tile are indispensable in the type of architecture so much in vogue in California. Gladding-McBean & Company has supplied terra cotta for many of the finest and largest residences and office and public buildings on the Pacific Coast.



Erection view of the head tower of cableway 8, showing the concrete counterweight and the tracks on which the tower moves laterally. Note super-elevation of the tracks on the left to resist side pull.

Construction of the Hoover Dam

*Description of the Aerial Cableways for the Transportation of Men, Materials, and Machinery.**

WESLEY R. NELSON.†

The head tower of cableway 7 under construction. In the background is the Arizona side of the canyon. The tail towers of cableways 5 and 6 can be discerned on the fill in the upper left-center of the picture.

AMONG the interesting and useful equipment for handling the immense quantities of construction materials for Hoover Dam are the ten cableways that span the gorge of Black Canyon at strategic positions in the mile-long zone of construction activities. Their facility for handling large machinery quickly and easily, and their rapid dispatch of men and materials to locations on the cliffs, have aided greatly in advancing the program of construction far ahead of schedule, and will insure rapid progress for the remainder of the work.

These aerial transports fascinate the observer as they move heavy loads with no apparent effort. A steel hook swoops down, virtually from the sky; cable slings are quickly adjusted about a caterpillar tractor, a 12-yard truck, or half of a 3-yard power shovel; and the object is lifted smoothly from the ground, carried easily upward and outward above the yawning chasm, and then gently lowered to the edge of the river or to some ledge high on the canyon wall.

At another place, on the Nevada rim, day-shift workers are disembarking from a cableway skip, and members of the swing shift are taking their places on the railed timber platform that hangs suspended from the 8-wheel track carriage above. The skip tender waves a signal to the hoistman, the skip rises from the ledge, hesitates as it nears the track cable, then moves at a speed of 1,200 feet per minute out over the canyon. At intervals during the trip, a projection on the button cable overhead picks up a slack-rope carrier from the group attached to the carriage, an expedient to prevent excessive sagging of the hoist line.

The skip tender waves his flag again, the skip loses headway, stops, swings pendulum-like for an instant, then starts the 700-foot descent to the canyon floor, dropping at the rate of about 300 feet per minute. Three minutes after leaving the Nevada rim of the canyon the skip has reached the canyon floor on the Arizona side. Had the men made the trip by highway, it would have taken from five to ten times longer. The signals of the skip tender for decelerating and stopping the skip are relayed to the hoistman by telephone by a signalman located in a look-out station on the edge of the canyon rim.

The cableways are of two types. One type has stationary towers and the other has movable, self-supporting towers. A track cable, or cables, runs from head tower to tail tower and, ordinarily, is fastened rigidly to an anchorage on one side of the canyon and, through a take-up device, to a similar anchorage on the opposite wall. At Black Canyon the anchorage for the stationary type is a structural-steel member concreted in a cross-cut at the end of a tunnel 30 or more feet long. The towers act as anchorages in the self-supporting, mobile type—a counterweight, thrust rail, and the weight of the tower taking the track-cable pull.

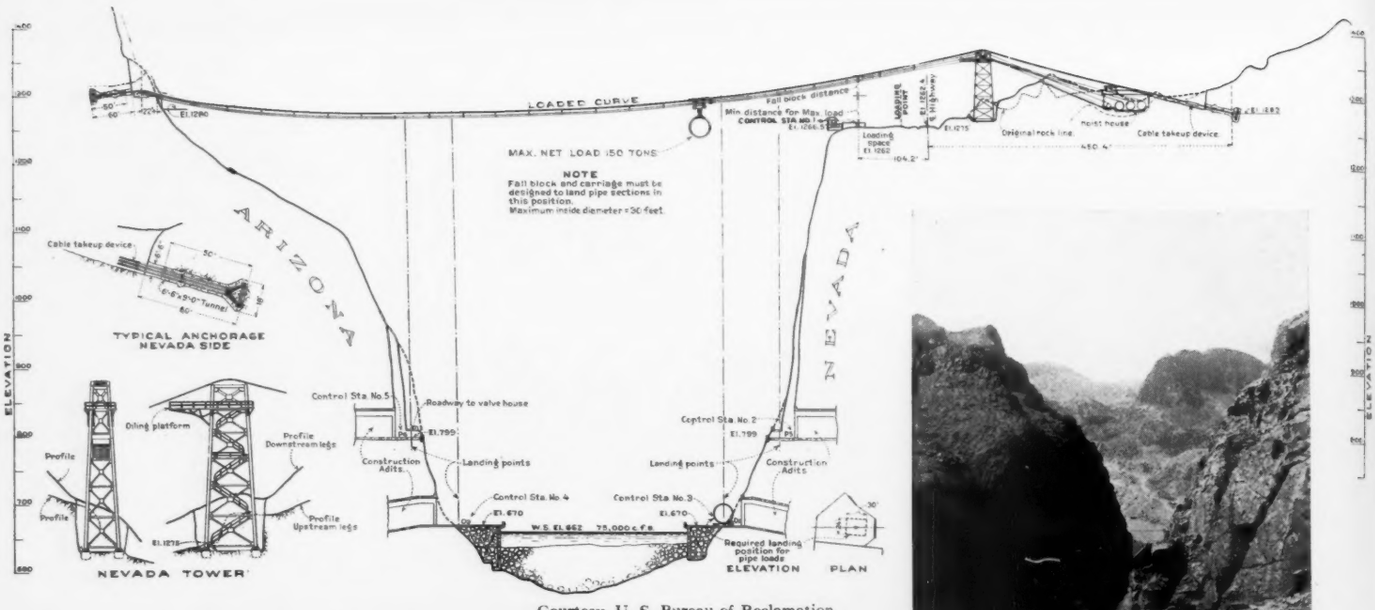
The power units and hoists are situated near the head tower in the stationary type and within the head tower in the movable structures. Each such assembly consists primarily of electric motors, a group of hoist drums, compressed-air units for hoist-drum brakes, and a control board for the cableway operations. In every mobile tower there is also an electric motor and winch for shifting it along its track. When both head and tail towers are movable, the winches in both are operated simultaneously by the head-tower operator through the same electrical hook-up. Movement is effected by an endless cable that is wound on the winch drum and reeved between fixed sheaves at both ends of the trackway and sheaves at the tower.

A carriage runs upon the track cable and carries the fall blocks from which the skip, concrete bucket, or other load is suspended. The principal parts of the carriage are the steel frame, traveling wheels, sheaves for dump and hoist cables, and horn for carrying slack-rope carriers. Loads are conveyed along the track cable by the outhaul and inhaul cable, lowered and raised by the hoist cable, and dumped by the dump cable. The button line provides for spacing slack-rope carriers as required.

The outhaul and inhaul cable is a continuous line which starts from the tailward side of the track carriage, runs to and through two sheaves at the tail tower, returns above all cables to the outhaul sheave at the top of the head tower, and then passes downward to and around the conveying hoist drum, upward to and through the inhaul sheave, and outward to the track carriage. The hoist cable is reeved between the sheaves of the

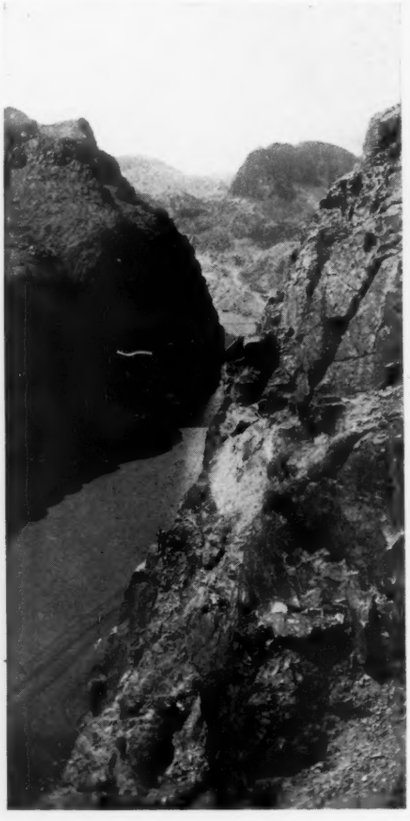
†Assistant Engineer, U. S. Bureau of Reclamation, Boulder Canyon Project.

*Fourteenth of a series of articles on the Colorado River and the building of Hoover Dam.



Courtesy, U. S. Bureau of Reclamation.

Profile of the Government 150-ton cableway.



Surveyors locating Nevada anchorage for a small cableway above the diversion-tunnel inlets.

Photo by B. D. Glaha

Looking down from a cableway signal tower upon a skip in mid-air. Below is the lower cofferdam under construction.

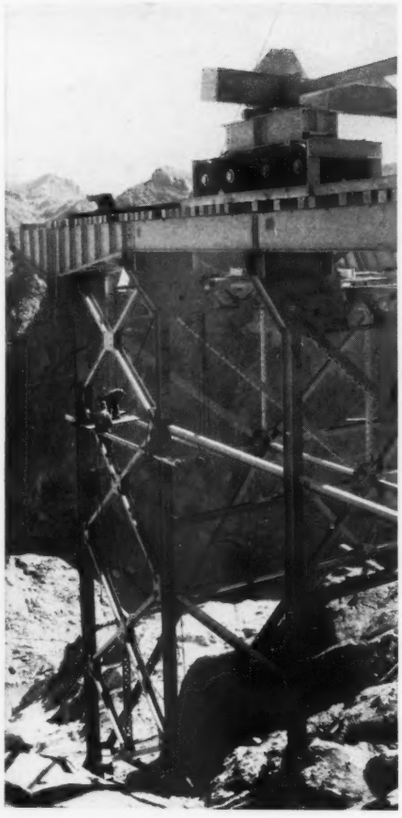
load fall block and of the carriage, runs to the hoist sheave in the head tower, and passes downward to the hoist drum. The dump cable leads from the drum of the dump hoist through the head-tower sheave to the track carriage, and thence to the dump block on the concrete bucket or other load.

The button line is fastened to the tail tower and runs just below the outhaul cable through a sheave at the head tower to a counterweight that holds the line taut. At intervals along the line are forged-steel buttons which engage or detach, one at a time, the slack-rope carriers that are carried by the track carriage. Thus, when the carriage travels away from the head tower, a fall-rope spacer is detached at each button, and, when the carriage returns, the spacers are picked up by the horn on the carriage. The carriers are provided to support the hoist and dump lines and to prevent them from sagging excessively between the head tower and the track carriage.

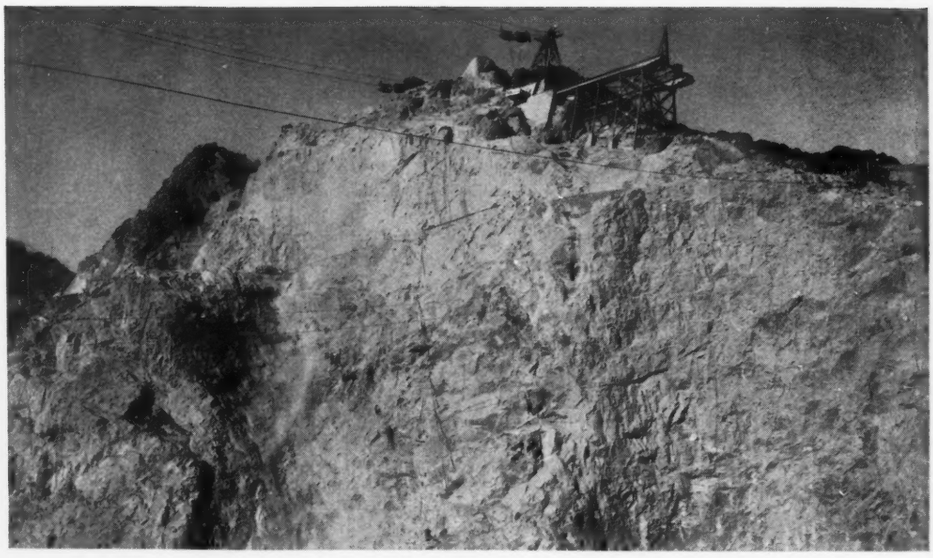
Among the first equipment placed in the canyon by Six Companies Inc. were several cableways, one above the outlet portals of the inner diversion tunnels and two of the same size across the upper portals. Later, after the Nevada section of the Black Canyon Highway had been extended to the top of the dam site, another service cableway was built above the sites of the canyon-wall valve houses—the head tower being located in a bay on the highway 800 feet from the top of the dam site. The hoist houses for these installations were placed in or near the head towers, or, in one instance, in the canyon near the river's edge.

The two cableways at the upper portals have been employed to move men and materials across the river, to aid in the construction of the foundations for the trash racks, to transport plate girders and steel members to the 50x50-foot steel gates, to assist in the erection of two double-track steel truss railroad bridges across the inlet portals of the Nevada diversion tunnels, and to carry workers to their positions on the canyon walls where they have been removing loose and projecting rocks. The cableway at the outlet portal has been used in the erection of the Stoney gates, while the one at the canyon rim has served to move trucks, power shovels, and other excavating machinery to the sites of the canyon-wall valve houses and the connecting outlet tunnels.

The dam, spillways, intake towers, and power house will occupy an area extending 2,000 feet along the canyon and 1,000 feet to each side of it, and will require more than 150,000,000 pounds of steel and 4,000,000 cubic yards of concrete for their construction. In order to provide ready access to all structures and to place these large amounts of materials in the shortest practical time, Six Companies Inc. has also built a group of five 20-ton cableways equipped with 3-inch diameter track cables and movable, self-supporting towers. These cableways are numbered



The steel trestle that supports one end of the trackway for the head tower of cableway 7.



Looking up the Nevada cliff at the head towers of cableways 7 and 8.

5 to 9 inclusive, from north to south. All head towers are on the Nevada side of the canyon.

Cableways 5 and 6 occupy the same runways on the landward sides of the spillway channels and will convey concrete for the construction of the two 150x650-foot spillway channels, the connecting 50-foot-diameter spillway inclined tunnel, the four 30-story, 75-foot-diameter intake towers, and the upstream portion of the main dam structure. Each has a span of 2,575 feet; and the maximum sag at the center when loaded is 151 feet—the distance from the lowest point of the cable to the crest of the dam being approximately 57 feet. The towers are of structural steel, 90 feet high, 46 feet in base width, and 32 feet in length along the track. They are parallel-traveling, and each is moved along its 600-foot runway by a Lidgerwood winch operated by a 100-hp. motor. The tracks on the Nevada side are almost entirely on rock, but those on the Arizona side are placed on a 130-foot fill made up of nearly 500,000 cubic yards of muck excavated from the spillway channel. They are of standard gauge, of 110-pound rails, and are spaced 45 feet 8 inches apart. Eight trucks, each having two pairs of 33-inch steel wheels, support each tower. The counterweight at the rear of every head tower contains 230 cubic yards of concrete weighing 929,300 pounds, and that at each tail tower contains 260 cubic yards of concrete weighing 1,052,000 pounds. The latter has a length of 48 feet and is 12x12½-feet in section.

The pull of the cable that tends to move the towers horizontally toward the canyon is counteracted by trucks, attached to the towers, which bear against a 100-pound rail placed with its web in a horizontal plane. The rail is fastened to an 8-inch timber which bears against a concrete curb. Steel rods, 2 inches in diameter and 13 feet long, hold the curb in position—the rods being sulphured in place in holes drilled in rock or connected to a continuous "deadman" of reinforced concrete in the fills. The horizontal trucks for each tower are 19 feet long and have ten 30½-inch double-flanged steel wheels.

The conveying and hoisting equipment consists of a 500-hp., 2,200-volt Westinghouse motor and of a 3-drum Lidgerwood hoist. The 1-inch-diameter inhaul and outhaul cable is wound on the rear drum, the ⅞-inch dump cable on the center one, and the ⅞-inch hoisting cable on the forward drum. Two 50-cubic-foot Ingersoll-Rand Type 30 two-stage compressors, operated by 10-hp. motors, are used for braking operations. The hoist drums are driven direct from the motor, which is reversible. The brakes on the hoist drums are of the external band type, and the friction clutches consist of wooden V blocks and steel friction cones. The band brakes are air released and counterweight set. Overload and overspeed devices set the brakes automatically.

The towers are in the shape of a right pyramid with the back leg vertical; are built of heavy structural steel; and are inclosed in corrugated sheet iron. The floors are of checkered steel plate; and, in order to eliminate the fire hazard, no wood is used. The towers and cableways are designed for normal operation with 20-ton loads and for maximum operation with 40-ton loads. The counterweights above the rear trucks of the movable towers have sufficient mass to balance the vertical pull of a 60-ton load on the cables. The connections between the trucks and the towers are effected through ball-and-socket and rocker joints to prevent the setting up in the towers of secondary stresses arising from inequalities in the cableway tracks or structural inequalities in the fabricated units.

Concrete for the downstream portion of the dam and the connecting structure between the power-house wings will be placed with the aid of duplicate cableway installations 7 and 8, which occupy the same runways at an average elevation of 113 feet above the crest of the dam. The head and tail towers are radial-traveling—the runway on the Nevada side being approximately 520 feet long and that on the Arizona side 450 feet.

The span between the towers is 1,405 feet, and the distance between the lowest point of the cables and the crest of the dam is 88 feet. Each head tower is 75 feet high, and each tail tower 42 feet. The runways are all in cuts, except where structural-steel trestles or concrete foundations have been built to cross ravines or to increase their lengths. On the Nevada side, old Lookout Point was removed in excavating the cut for the runway; and, in order to join the coverage of cableway 6, the runway was extended 100 feet northward by a steel trestle 56 feet high.

The horizontal pull on the head tower induced by the cableway load is resisted by super-elevating the front tracks on an approximately 25° incline from the horizontal. The tracks have the same gauge as those of cableways 5 and 6, and the distance between the center line of the tracks is 42 feet 3 inches. Other features of the equipment, dimensions, size of counterweights, and details of the cables are practically the same as those of No. 5 and No. 6, the power units and hoists being duplicate installations.

Cableway 9 is a radial-traveling type with the head tower fixed and the tail tower movable throughout a spanning radius of 1,374 feet and an arc of approximately 600 feet. This installation covers practically the entire area of the power-house wings. The runway track of the tail tower is 6 feet below the elevation of the crest of the dam, and the base of the head tower is 56 feet above the dam. The tail tower is 17 feet high, and its

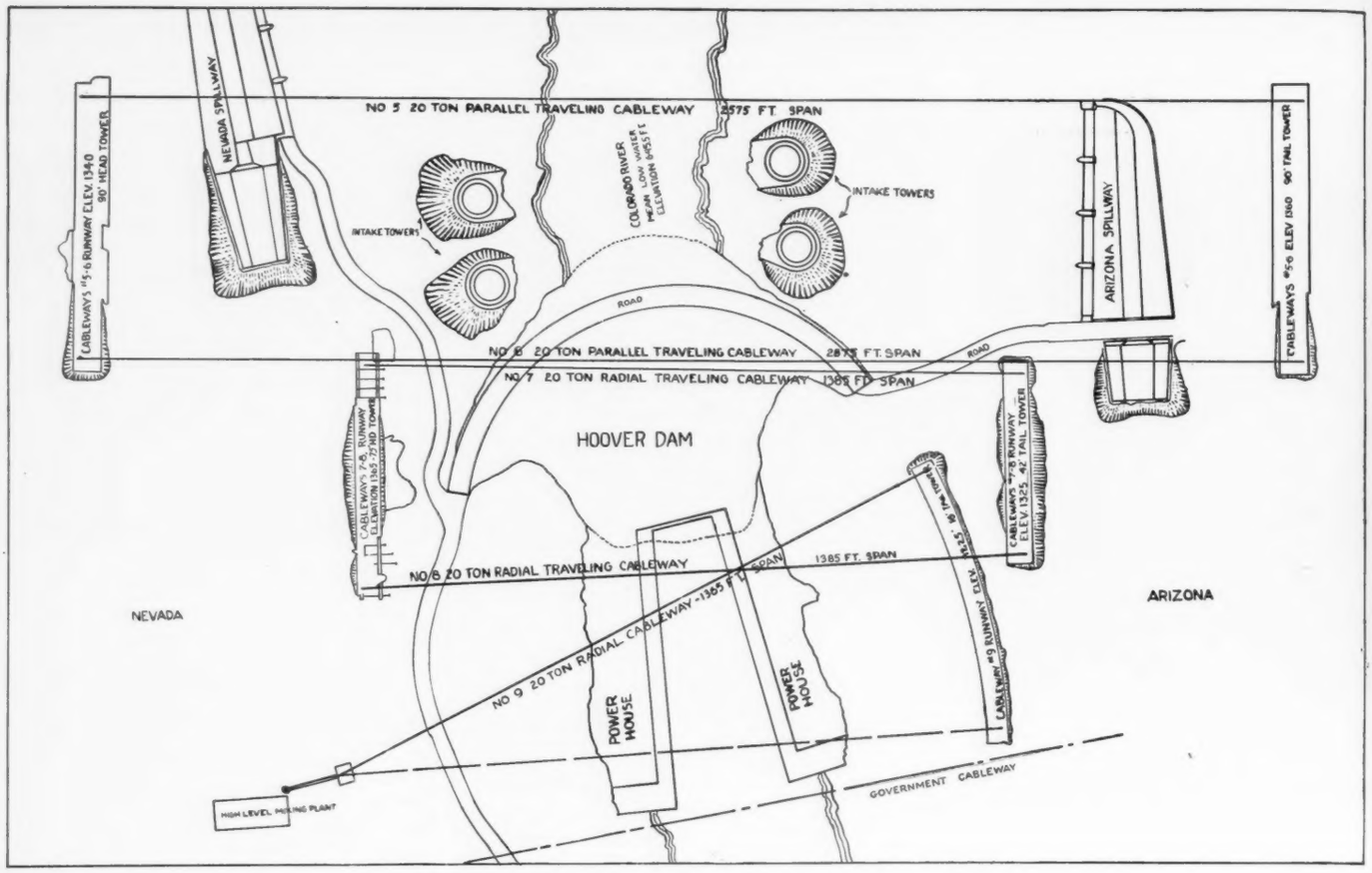
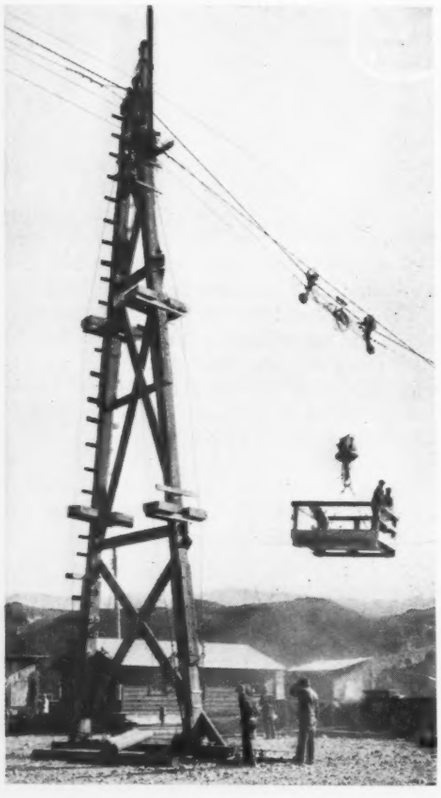

NO 5 20 TON PARALLEL TRAVELING CABLEWAY 2575 FT SPAN
NEVADA SPILLWAY
CABLEWAYS #5-6 RUNWAY ELEV. 1340 90' HEAD TOWER
COLORADO RIVER MEAN LOW WATER ELEVATION 1495 FT
INTAKE TOWERS
INTAKE TOWERS
ARIZONA SPILLWAY
CABLEWAYS #5-6 ELEV 1360 90' TAIL TOWER
ROAD
NO 6 20 TON PARALLEL TRAVELING CABLEWAY 2875 FT. SPAN
ROAD
NO 7 20 TON RADIAL TRAVELING CABLEWAY 1365 FT SPAN
HOOVER DAM
CABLEWAYS 7-8 RUNWAY ELEVATION 1420 90' HEAD TOWER
CABLEWAYS #7-8 RUNWAY ELEV. 1325 42' TAIL TOWER
NO 8 20 TON RADIAL TRAVELING CABLEWAY 1365 FT SPAN
1365 FT. SPAN
NEVADA
ARIZONA
NO 9 20 TON RADIAL CABLEWAY - 1365 FT SPAN
POWER HOUSE
POWER HOUSE
CABLEWAY #9 RUNWAY ELEV.
GOVERNMENT CABLEWAY
HIGH LEVEL MIXING PLANT

Diagram showing the locations of the five 20-ton cableways which will play a leading part in all subsequent construction activities.



Head tower, carriage, and skip of a small cableway which crosses the canyon above the valve houses.

counterweight contains 98.6 cubic yards of concrete weighing 400,000 pounds. The horizontal pull on the tower is resisted by a central horizontal rail in a manner similar to that in cableways 5 and 6.

The head tower is an A frame of structural steel 98 feet high and 32 feet in base width. The two side columns are connected by lattice bracing and supported through pin connections by steel shoes. The tower is braced near its top by a structural member which bears, through a hinge pin, against a base plate set in the solid rock of the cliff on the north side of the structure. The track cable and tower are guyed to the track anchorage by two 2¾-inch guys, the anchorage consisting of four 3½-inch steel rods and a structural-steel cross member concreted in a long tunnel and crosscut. The hoist house is located at the base and on the riverward side of the head tower. The power and hoisting equipment is of the same size and type as that of cableways 5 and 6. The travel of the tail tower is controlled electrically by the operator in the hoist house.

The concrete for Hoover Dam will be made at two locations: at the Lomix plant in Black Canyon, 4,000 feet upstream from the dam site, and at the Himix plant at the end of the United States Construction Railway on the Nevada rim and approximately at the elevation of the crest of the dam. Roadbeds have practically been completed for the railroads both from the Lomix plant to the dam site, running beneath cableways 5 to 8 inclusive, and from the Himix plant to the Nevada spillway, running beneath all cableways. At the time of pouring the main dam structure, the contractors plan to mount 8-cubic-yard bottom dump buckets on flat cars to transport the concrete from plants to cableways and by cableways from cars to pouring sites. Each bucket with its load will weigh about 20 tons.

The dam will be poured in vertical columns, approximately square in section and varying in side dimensions from 60 feet at the upstream face to 25 feet at the lower face. The concrete is to be placed in horizontal layers not exceeding 5 feet in thickness, and the tops of the columns will at no time differ more than 35 feet in elevation. The rate of placing the concrete is restricted by specifications to a pour of not more than 5 feet in depth in 72 hours and not more than 35 feet in depth in 30 days. On this basis, at least 21 months of continuous mixing will be required to pour the 730-foot dam, or an average for the 3,400,000 cubic yards of 162,000 cubic yards per month. In addition, nearly 700,000 cubic yards has to be placed in the appurtenant structures.

Taking into consideration other factors, and assuming average working conditions, the concrete plants and cableways will be required to operate with slight cessation from the summer of 1933, the time the first concrete will be poured in the main structure of

From left to right are the Nevada towers of cableways 8, 7, 6, and 5. Railroad tracks will be laid on the ledge in the foreground.

the dam, until the project is completed in 1937.

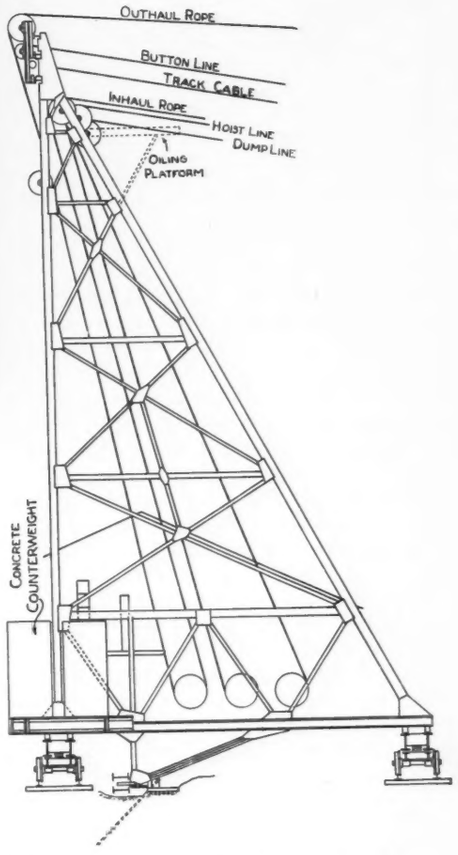
The five cableways last described present unusual features of interest, but their capacity to move heavy loads is dwarfed by the huge Government installation which is to handle the steel penstocks and outlet pipes, the 30-foot-diameter steel penstock headers, and the turbines and machinery of the power plant. This cableway will be capable of conveying, lowering, and raising 150-ton loads. Its track will consist of six 3½-inch steel-wire cables spaced 18½ inches apart in a horizontal plane and supported on a structural-steel tower on the Nevada side and on a steel-and-concrete saddle on the Arizona side—the track cables being connected at each end to eyebars embedded in concrete anchorages.

The carriage will be operated at a speed of approximately 240 feet per minute, and will have means for acceleration and deceleration—the total length of travel being 1,050 feet of the 1,200-foot span. The load speed of hoisting and lowering will be about 30 feet per minute for 40- to 150-ton loads and 120 feet per minute for lighter loads. Provisions will be made for creeping speeds when conveying, and inching speeds when raising or lowering.

Cableway operations will be controlled from five stations. No. 1, for the chief operator, will be located in a lookout projecting 20 feet beyond the edge of the canyon wall and supported by steel I-beams anchored in a concrete foundation. The four other stations will be at the landing platforms at the portals of the construction adits which lead to the penstock header tunnels. The chief operator will direct the conveying of the load from the head tower out and over one of the other stations, when the control will be transferred to the designated station where an operator will direct its lowering or raising, having it in his power to move it at creeping speeds within a restricted zone. Transference of control between stations will be made with all equipment deënergized and all cable movements halted. Resumption of operations will be made by means of a definite interlock with the station assuming control. Each station will be provided with red and green signal lights to show which particular one is energized. All stations will be connected by a telephone system.

The hoisting machinery will be installed in a house located between the head tower and the anchorage on the Nevada side of Black Canyon. Each drum of the hoisting and conveying equipment will be run by a separate motor. Each hoist drum will be of sufficient diameter and length to wind the cable in a single layer. Heavy-duty and energizing brakes will be provided, and these will be capable of sustaining the full load under all conditions of operation, including interruption of the power supply. The lowering of heavy loads will be restrained by electric regenerative braking, and the loads are to be decelerated by dynamic braking before the application of the service brakes. These will function automatically in case of power-supply failure—decelerating promptly and holding the maximum load. Each drum will have an emergency brake that will automatically decelerate and hold the load in the event of overspeed or other contingency. The structural-steel head tower is 100 feet high and 25x35 feet at the base. The height was established by the allowance that would permit the largest load to clear with safety a parapet wall in front of the tower.

Operation and control will be by direct

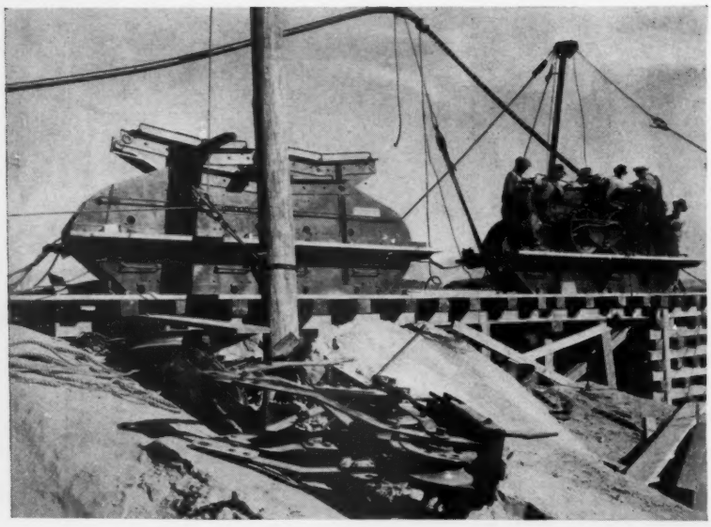


Side elevation of a 90-foot head tower, showing arrangement of the various cables.

current generated by a 3-unit motor-generator set. The 300-hp., 1,000-revolution per minute motor will receive energy from a power station supplying 3-phase, 2,200-volt current. The generator will have a rating of 250 kw., 1,200 revolutions per minute, and 550 volts. The exciter will be of the 4-pole, 15-kw., compound-wound type.

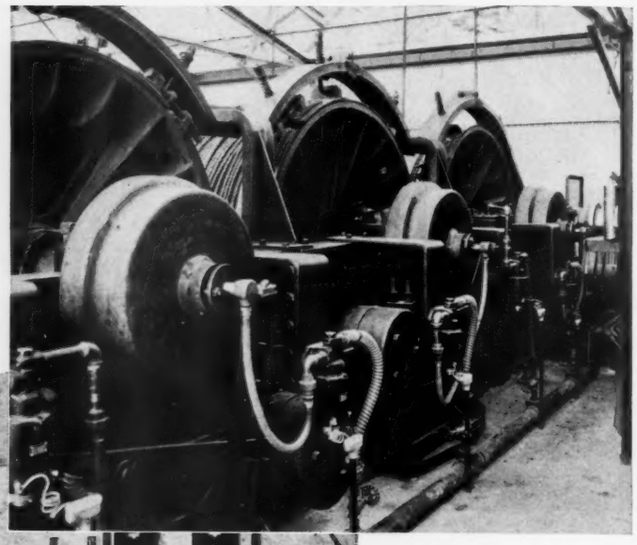
Each of the three driving motors will be separately excited and shunt wound. The conveying motor will be rated at 400 hp. and 900 revolutions per minute, and each of the hoist motors at 175 hp. and 225/900 revolutions. Limit switches will govern the extent of travel of the track carriage and the fall blocks and will control the conveying, hoisting, and lowering operations.

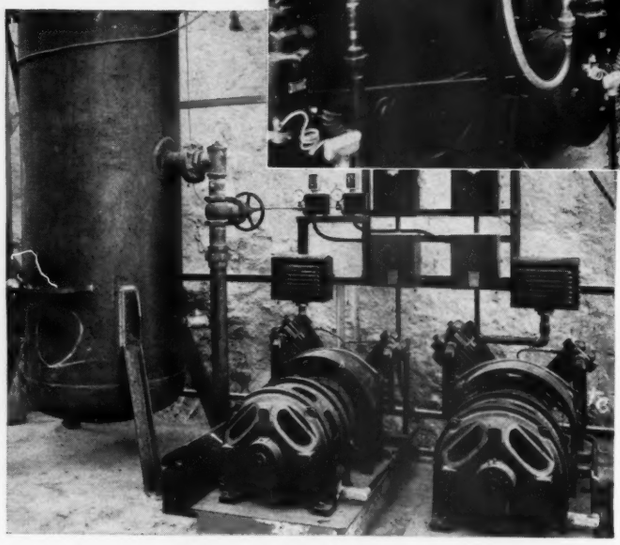
The anchorages at both ends of the cableway will be of the mushroom type, consisting of 6½x9-foot tunnels leading into chambers of approximately 18x18x10 feet. The bulbs and at least 50 feet of the tunnels will be filled with concrete. The metalwork will consist



Left—Erecting the track carriages of a 20-ton cableway.

Below—Three-drum Lidgerwood hoist installation for cableway 9, showing the counterweights and air cylinders for braking.





One of five similar Type 30 air-compressor installations which supply air for the hoist brakes on the five 20-ton cableways.

of six bar-and-pin units connected to a 13x13-foot grillwork of heavy structural steel in the bulb of the excavation. The take-up device for the track cables will be made up of six 60-ton hydraulic jacks, one for each cable, mounted in toggle joints and installed between the Nevada anchorage and the hoist house.

The steel operating cables will include two 1⅜-inch conveying lines, two 1⅜-inch hoist cables, and two 1-inch button lines. The conveying drum in the hoist house will be 8 feet in diameter and 10 feet 5¾ inches long, and each of the two hoist drums will be 13 feet in diameter and 17 feet long. The rotations of the conveying and hoist drums will be electrically equalized by two Selsyn generators and a Selsyn differential motor so that the load when being conveyed will remain the same distance below the track cables.

The track carriage will carry 48 rollers—eight for each track cable, all of 24-inch tread diameter. The diameter of the hoist sheaves on the carriage and of the two fall blocks will be 35 inches, the same as that of the sheaves on the tower. The two connected fall blocks will carry the load by a single pin and links—hooks for the purpose not being permitted. The button lines will have button projections at 100-foot intervals. Two sets of slack-rope carriers are to be provided, one set for each hoisting and inhaul cable.

The hoists will be equipped with heavy-duty service and emergency brakes. Service brakes will be of the solenoid-operated, spring-set type installed on the commutator side of the driving motor. Each hoist is to be equipped with an emergency brake having a 10-inch band lined with a ½-inch thickness of Ferodo lining. This latter brake will be set by a heavy spring and released by an electrically operated thrustor that will enable the operator at any control station to set the brake at will as well as to cause it to be applied automatically in case of current failure. An overspeed device on each hoist will set the service and emergency brakes in the event of overspeeding or current failure. Owing to an adjustable speed device, the brakes cannot be applied other than smoothly and gradually.

When the cableway carries a load of 150 tons, the pull will be 2,058,000 pounds on the Arizona anchorage and 2,100,000 pounds on the Nevada anchorage. The components of this force at the head tower will amount to 880,000 pounds vertically and 29,000 pounds horizontally. The maximum tension on the inhaul and outhaul cable will be 47,000 pounds. Track cables have been designed with a factor of safety above 3, and conveying and hoisting ropes with a factor of safety greater than 4½. The breaking load of each track cable is 1,070,000 pounds or 6,420,000 pounds for the six cables, and the breaking strength of the conveying as well as of the hoisting cable is 106,000 pounds.

The engineering department of Six Companies Inc., under the direction of General Superintendent Frank T. Crowe, Chief Engineer A. H. Ayers, and Office Engineer J. P. Yates, designed the movable towers and runway structures. The Lidgerwood Manufacturing Company, of Elizabeth, N. J., furnished the hoists and cableways for the five 20-ton installations, and the Consolidated Steel Company, of Los Angeles, Calif., erected the movable towers. The contract for furnishing and erecting the 150-ton Government cableway was awarded to the Lidgerwood Manufacturing Company on its low bid of $172,110. Westinghouse motors are used in the Six Companies Inc. installations, and General Electric motors, generators, and electric equipment will be used in the Government cableway.

As has been mentioned in previous articles of this series, Hoover Dam is being built by the United States Government through the Bureau of Reclamation. Dr. Elwood Mead is commissioner and administrative head of the Bureau; R. F. Walter is chief engineer in charge of design and construction; Walker R. Young, as construction engineer, represents the chief engineer on this project and has direct supervision of the building of the dam and appurtenant works. Principal contractors carrying on the construction are Six Companies Inc. of San Francisco, and The Babcock & Wilcox Company of New York. The contracts awarded these two concerns are the largest ever let by the Bureau of Reclamation, and total approximately $59,000,000.

A glimpse of the spray room and, at either side, reproductions of cards treated there.

How Your Greeting Cards Get Their Borders

THE use of compressed air in spraying colored borders on greeting cards has proved to be one of the factors that has made possible the creation and merchandising at moderate prices of the beautiful and artistic cards that are now available for all occasions.

This delicate use of a medium that is ordinarily associated with construction work, heavy industries, and a vast array of other prosaic applications, only serves to emphasize the flexibility of compressed air and adds a romantic touch to the chronicle of its accomplishments.

Hall Brothers, Inc., of Kansas City, Mo., creators of Hallmark greeting cards, discovered in due time that cards with colored edges had a much wider appeal than the plainer kind. Manufacturing stationers were applying these edges, mostly gold and silver, by a slow and painstaking hand method, using at the same time an expensive gold and silver leaf. Artisans in this craft developed in consequence; and their services were in continual demand. But stationery and greeting cards are two different products; and it soon became apparent to the manufacturers that "leafing" these colors on the edges of cards, while unquestionably giving them a distinctive finish and an elegance of their own, was slow and expensive—in fact, prohibitively so, as greeting cards sold for as little as a few cents each. In other words, their problem became one of production with a definite quality to be maintained.

The purchase of an air compressor which operated spray guns applying colored lacquers to the edges of cards proved to be the solution for Hall Brothers, Inc. While this firm does not claim to have been the first to utilize the air brush for this purpose, its experience is typical of the industry.

The initial installation was an assembly of the various units needed, and was built mostly of used parts. It consisted of a motor-driven air compressor with a displacement of 10 cubic feet per minute and a discharge pressure of 100 pounds. The machine was equipped with an automatic start-and-stop switch. Air lines were run to three DeVilbiss hand spray guns with suction feed cups. In these cups were mixed the colored lacquers and the gold and silver bronzes used. Working in metal booths, with an overhead ventilating system exhausting the fumes, girls applied the colors to the edges of the cards.

Originally, the experiment met with many discouragements, as qualified help could not be found. The cards were "fanned" out to allow only a narrow edge to be exposed, the colored lacquers then being sprayed on. If other edges were to be so treated, the cards were merely turned around and the fanning process repeated. At the start, the fanning of the cards really proved to be more of an accomplishment than the operation of the gun, but the workers gained adeptness with practice. Ordinary cards, measuring 5x6 inches, with one color on each of the four edges, could at first be bordered at the rate of only about 1,000 an hour. When a speed of 3,000 was attained, it was thought the limit had been reached. However, with experience and the adoption of a piecework rate of pay, the speed was brought up to around 6,000 an hour. The difference between edging 6,000 an hour and 1,000 an hour naturally effected a considerable reduction in costs.

The original installation proved quite satisfactory for a number of years. But then it was discovered that when three guns were operating simultaneously the pressure was not great enough to maintain maximum efficiency at each gun. Consequently, an additional compressor was provided. The new unit is a motor-driven machine with a piston displacement of 8 cubic feet per minute and a discharge pressure of 100 pounds. It has automatic stop-and-start regulation, and discharges into a receiver from which the air is piped to the working booths. The air is filtered to remove oil, water, and dirt, and is reduced to a pressure of from 25 to 30 pounds for spraying. Each of the two compressors now supplies two spray guns.

Colored lacquers are reduced with a thinner, while gold and silver bronzes are mixed with clear lacquer and with a good grade of lacquer thinner. The work is done in four metal booths, each about 4 feet square, with an overhead ventilating system consisting of a 24-inch exhaust fan.

Many types of greeting cards have their edges decorated by this process. Cardboard and paper stock, both in single and double sheets and sometimes folded in many odd ways, are brightened up in the booths. Linen, vellum, and ripple and other novelty finishes are bordered, as are parchments, tissues, and even newsprint. French borders—red and gold, for example, on the same edge—are frequently used, such combinations being obtained by spraying one over the other, the basal color being somewhat wider.

The water-coloring of designs on the faces of cards with spray guns and by the aid of stencils is another use to which the greeting-card industry has put compressed air. It is, however, not so widespread as is the process for coloring edges.

"Hu-Actinite" helps to give the putting greens at Herman Park Municipal Golf Course a velvety surface.

Concrete settling tanks, with rose garden in the foreground. Above—Chlorinating plant and office building.

Houston, Texas, Turns Waste into Profit

F. W. SULTAN, JR.

THE City of Houston, Tex., has turned the troublesome problem of disposing of its sewage into what promises to be a profitable enterprise for the manufacture of fertilizer. Back in 1919 a small experimental plant for this purpose was built according to designs prepared by Assistant City Engineer G. L. Fugate. It was the first activated-sludge sewage-treatment plant ever constructed to serve a city of more than 100,000 population. In it was produced the first carload of dehydrated activated sludge to be sold as a fertilizer ingredient. This experimental plant was destroyed by fire, but not until after it had been the means of developing a satisfactory process that would do the work for which it was built. The experience gained there made it possible to design a new, modern plant which was placed in operation in 1932. This is now running smoothly on a regular production basis, and is manufacturing about 15 tons of fertilizer daily.

"This process of sewage treatment," to quote Mr. Fugate, "is the only one that converts the waste of a big city into a useful and salable product, practically without nuisance, all within the period of a day. The waste originates in the home or factory, is collected, treated, and the residue dehydrated and loaded into a car in less than 24 hours."

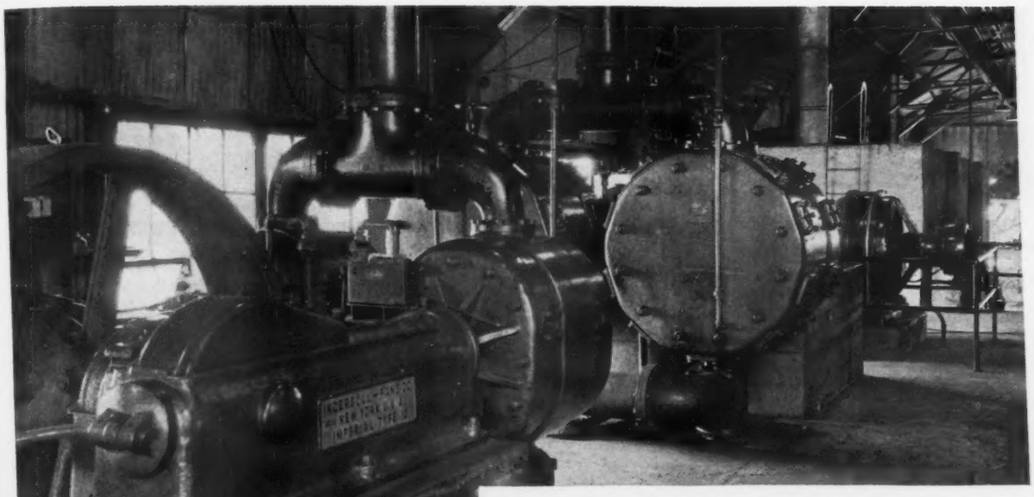
The fertilizer plant was built to operate in conjunction with one of the city's sewage-disposal plants that handles an average of 13,500,000 gallons a day. The sewage is run into large concrete tanks, where it is activated by means of low-pressure air furnished by one centrifugal blower of 13,500 cubic feet per minute capacity, and two Sturtevant blowers each with a capacity of 3,000 cubic feet per minute. One of the small blowers serves as a spare unit. After being thoroughly oxidized, the sewage passes into four large settling tanks, each of which has a diameter of 65 feet at the bottom. Here the solid matter settles out and the clear water overflows and runs into an adjacent bayou. Some of the solid material is recycled into the raw, incoming sewage to start the activating process. The remainder, consisting of an average of 300,000 gallons a day, is delivered to the fertilizer plant.

The fertilizer plant receives the sludge in mixing tanks, where it is treated with chlorinated copperas which has been prepared previously in a separate tank and which is transported under air pressure through a hard-rubber pipe line. A 3½x4-inch Type 15 compressor supplies the air for the latter purpose. The chemical is distributed through the sludge; and at the end of the tank provision is made for measuring electrically the pH, which denotes its acidity or alkalinity.

From the mixing tank the sludge goes to a battery of four Oliver United disk-type filters for drying. Combined, these filters provide 3,200 square feet of filtering surface, and each square foot is capable of producing from ½ to 1 pound of dry material an hour. As one of our illustrations shows, each filter consists of a series of disks. These revolve and are under a vacuum while in the sludge and for a time after they emerge from it. As a portion of the disk approaches the point of discharge, the vacuum is cut off and compressed air is applied to cause the dry cake to drop off. A scraper removes any part of it that remains. The vacuum for the filters is supplied by two Ingersoll-Rand vacuum pumps—a Type XRB 30&30x12 unit, and a 20&20x12 Type XB-1 machine.

The filter cake is carried to a storage bin, and from there it is withdrawn and moved by screw conveyors to two long, cylindrical driers which resemble rotary kilns. These are both 60 feet long and have diameters of 5 feet and 6 feet, respectively. Oil is used as fuel, and draft is induced by suction blowers. The driers are fitted with complete temperature-recording apparatus.

From the driers, the material discharges through a magnetic separator which takes out all ferrous metal and drops it into a pocket. The dried sludge is delivered by belt to an electric screen. The rejected portion, consisting largely of pellets formed in the driers, is returned to the feed end of the drier and mixed with the wet cake. That which passes the first screen is conveyed to two other screens, arranged in tandem. The first of these removes the dust, and the product of the second is the finished fertilizer. The material rejected by the screens is ground and passed over them again. The fertilizer is weighed on automatic scales, after which it goes to a storage bin to await loading into



Left—Vacuum for dewatering the sludge is furnished by these two pumps.

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Center—As the dewatered sludge is conveyed through cylinders it is dried by oil flames.

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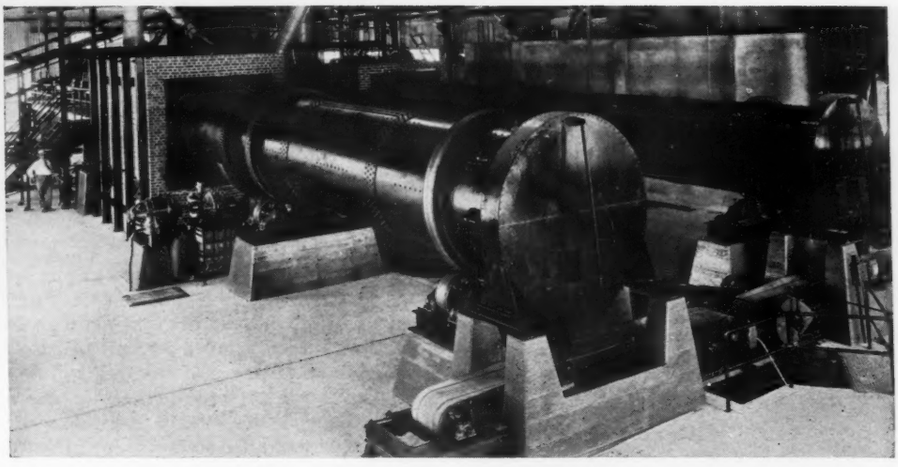
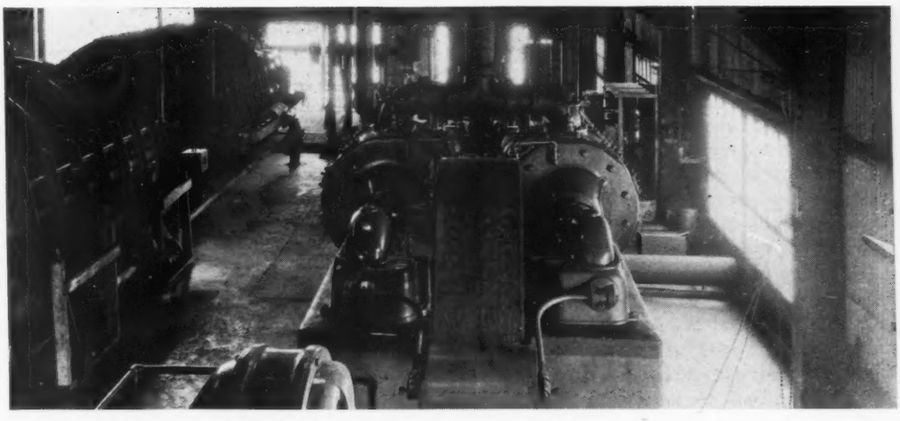
Bottom—Another view of the vacuum pumps and, left, two of the filters.





box cars for general distribution.

By this method of operation the fertilizer plant eliminates the slow and expensive system of drying the sludge in lagoons or sand beds. Because of inclement weather conditions, it sometimes requires as much as 100 days to complete the latter process. Extensive land purchases at costly figures have been done away with, as has the expense of periodically cleaning the sand beds.

The fertilizer plant is handling sludge made from sewage from a population of approximately 175,000 persons. In addition to the large treatment plant, from which most of its raw material is derived, Houston has six other smaller ones. Present plans are to replace these with one large plant, which will also have a fertilizer plant operating in connection with it. The sanitary authorities are laying out the system on the theory that the future growth of the city will approximate past gains. This previous accretion has been somewhat remarkable—Houston having recorded 12,000 inhabitants in 1870; 60,000 in 1900; 168,000 in 1920; and 300,000 in 1930.

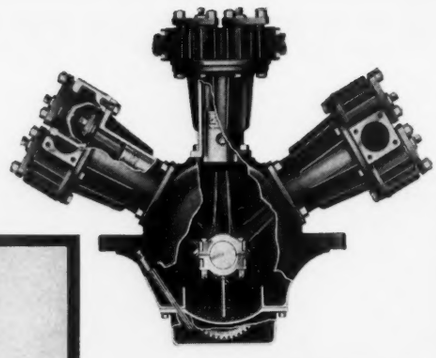
The fertilizer plant is ably operated by a staff under the direction of R. D. Linkhart, as superintendent. Mr. Linkhart has taken an interest in developing uses for the product and has been active in demonstrating its value as a fertilizer.

The fertilizer is marketed under the name "Hu-Actinite," which is derived from the city's name and the designation of the product. As it comes from the plant, it contains 6.7 per cent of ammonia and 3.5 per cent of available phosphoric acid. As it contains organic nitrogen, it is a soil builder as well as a plant food. Excellent results have been obtained with it in growing roses and other flowers, and vegetables. In Houston, it is held to be unequaled for lawns. The city has been using it on the putting greens of the Herman Park Municipal Golf Course, which is conceded to be one of the finest city-owned courses in the South.

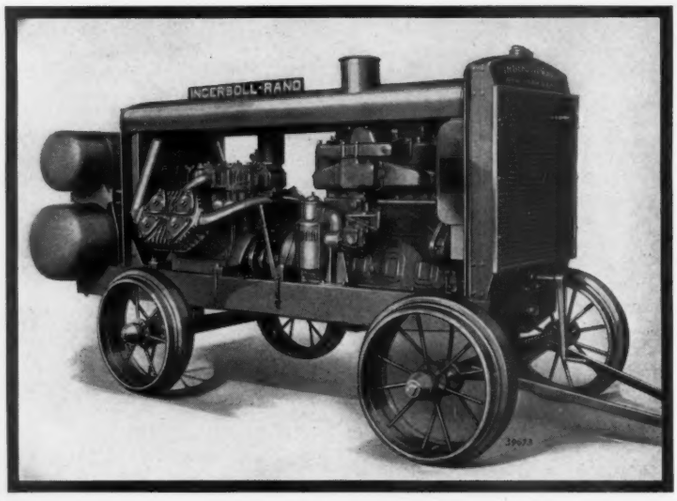
"Hu-Actinite" has demonstrated its value as a fertilizer for strawberries, for rice, and for corn. It is also employed as a base material for the making of a commercial fertilizer which is used extensively for cultivating cotton. This product contains 4 per cent of nitrogen, 8 per cent of available phosphoric acid, and 4 per cent of potash.

Although this municipal activity may eventually be a revenue producer, those responsible for it are concerned primarily with its hygienic aspects. At present, the fertilizer plant merely breaks even—that is, it pays for the disposal of the dry material after it leaves the treatment plant. Normally the fertilizer brings from $15 to $20 a ton; but higher prices or greater output would probably put the plant on a profitable basis.

New Portable Compressor Shows Great Economies

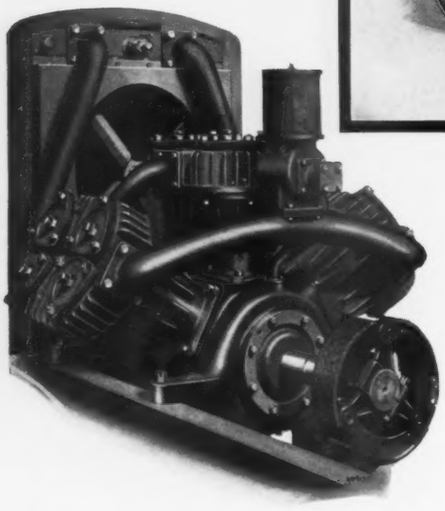


Above—Cutaway view of the 2-stage, air-cooled compressor.



Left—The 370-cubic-foot unit on rubber-tired steel wheels.

Below—The compressor assembly, showing the clutch and intercooler.



PORTABLE air compressors first appeared about twenty years ago and became popular almost at once. They proved particularly suitable for many classes of construction work, such as excavating and roadbuilding, where the operations were of a temporary nature and frequently spread over considerable areas. Their advent ended the necessity of moving and setting up heavy, bulky, stationary compressors which required the laying of expensive foundations. In fact, their introduction led to large savings in both time and money.

During the intervening years, portables have become indispensable equipment for contractors, quarrymen, and construction and maintenance departments of all kinds. The machines, themselves, have undergone continual changes and refinements, but have largely held to the same general design that characterized the earlier models.

Now, however, there has been developed by Ingersoll-Rand Company a new portable compressor which is a complete departure from the traditional machine. Through it, substantially all the inherent advantages of modern stationary compressors have, for the first time, been made available for transitory service.

Remarkable economies over existing types are effected by this new machine. Size for size, it will deliver 23 per cent more air than the old type on a given amount of gasoline. Stated another way, the new unit will do the required work at three-quarters of the fuel cost of a machine of the prevailing type. These figures are based on comparative tests between unused machines of the two classes. Its increase in efficiency ranges up to 50 per cent when compared with a worn unit of the old type. Such a comparison may not seem entirely proper at first glance; but, actually, it is relevant, showing as it does the gain the owner of a used portable can make by discarding it in favor of a new model of corresponding size. These economies are not attributable to any one improvement alone, but to the combined effect of the numerous advances which are embodied in the new compressor.

The most outstanding feature is the use of 2-stage compression. As is well known, air can be compressed from normal pressure to 100 pounds pressure considerably more efficiently in two stages than in one stage. Two-stage compression involves cooling the air between stages. For this purpose a very ingenious air-cooled intercooler has been developed.

The temperature of the air at the compressor outlet is 200°F. cooler than when using single-stage compression. This serves virtually to eliminate carbon deposits and insures the valves against breakage or leakage from the effects of heat. These and other advantages help to maintain the original efficiency of the unit over a long period of service. A valve recently taken out of one of these new machines after 2,000 hours of service was entirely free from carbon and in perfect condition in every way.

Air-cooling does away with the danger of freezing in the compressor and intercooler and with the incidental bother of maintaining a water supply. Interstage cooling removes moisture and supplies drier air to tools. By reducing temperatures, the problems of lubrication are simplified. The 2-stage machine has many additional advantages over the single-stage unit at high altitudes and in hot climates.

Power is furnished by a new Waukesha 4-cylinder, heavy-duty gasoline engine with patented "Full-Power" combustion chamber. This chamber, which is found in no other portable-compressor engine, produces a highly turbulent fuel mixture, induces rapid and complete combustion, and greatly improves volumetric efficiency. The engine was designed especially for this service, and each of the various sizes produces at least 30 per cent more power than is required at full load and full pressure.

Interposed between the engine and the compressor is a new and 100 per cent reliable clutch which provides for easy starting. This clutch, unlike others, has no sliding member to wear or break. Main bearings are of the Timken roller type. These reduce friction and add to the mechanical efficiency of the assembly.

The new portable has improved regulation. Low-pressure inlet valves are used only to admit air, and not to regulate. The speed of the machine is automatically reduced when it is not compressing. All working parts are readily accessible for inspection or adjustment. An entire cylinder assembly can be removed by one man.

These new 2-stage, air-cooled units are made in four sizes having piston displacements of 125, 185, 250, and 370 cubic feet per minute. Mountings suitable for any service are available.

HIGHLY REFRACTORY CEMENTS FOR ELECTRIC FURNACES

AS AN example of the refractoriness of its new magnesia cements for lining the melting chambers of both ferrous and nonferrous electric furnaces, Norton Company of Worcester, Mass., cites the case of a 4-ton induction furnace used in the production of quality stainless steels. In furnaces of this type are reached extremely high temperatures—the maximum attainable, however, depending upon the effectiveness of the lining. The melting chamber of the unit in question is faced with Norton Magnesia RM-1118 Cement, which is said to have given as high as 76 consecutive heats at a pouring temperature of 3,150° F. Equally satisfactory results have been obtained with nonferrous furnaces and high-copper alloys, the cement in that case being of the grade known as RM-1005.

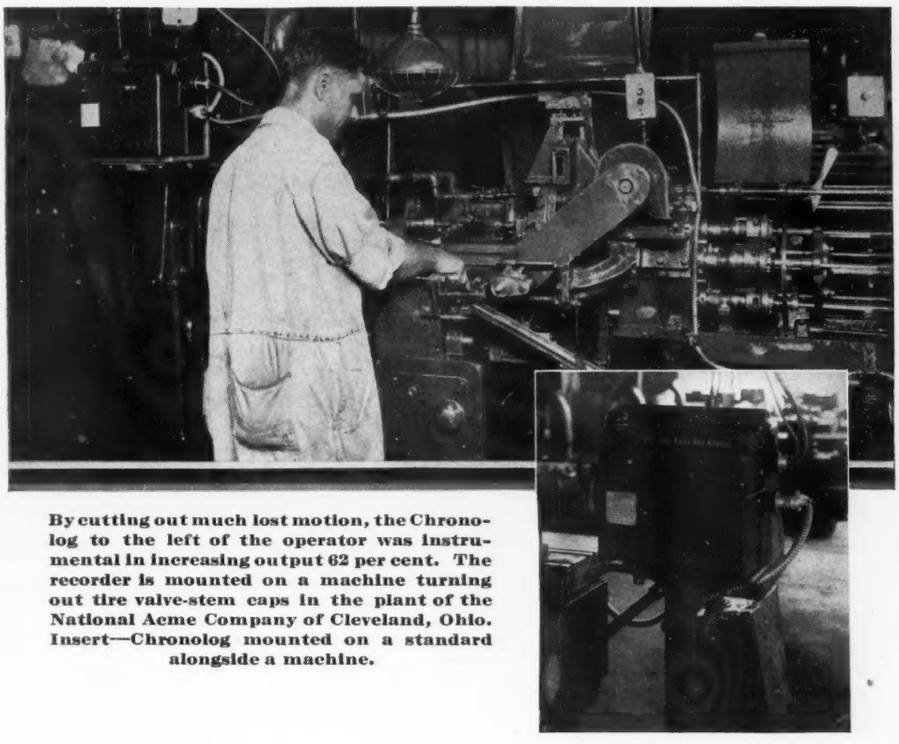
The refractory consists largely of magnesite from California, where it is obtained in an exceptionally pure form. The raw material is transformed in the electric furnace into a very dense and stable magnesium oxide that is carefully sized before selected binders are added. Aside from its own superior qualities, the method by which the cement is applied also has much to do with the ultimate success.

In powdered form the dry magnesia cement is first placed in the inside wall of the induction coil, which has been lined permanently with special silicon-carbide shapes. This powder is next tamped down tight with a compressed-air or other hammer until the level of the melting-chamber bottom has been reached. On this surface is laid a piece of asbestos board of the right diameter, and on top of this is stood upright a cylinder of the same material. This constitutes the melting chamber—the asbestos shell being supported on the inside by a steel core. Following these preparations, more dry cement is rammed in between the silicon carbide and the asbestos and up to the line where the metal will come. From that point up to the top of the furnace is applied another kind of cement that sinters to a harder mass and holds the lower part of the lining in place during the pouring operation.

With the packing completed, the furnace is slowly heated to get rid of all moisture and extraneous gases that may be present. This is effected through the electrical resistance offered by the steel core. It is then permitted to cool, after which the core is removed; the charge placed in the melting chamber; and the furnace brought up to the desired temperature —the asbestos coming to the surface as slag without contaminating the metal.

Rain falls during a rainfall but clouds do not burst when there is a so-called cloudburst, according to United States Weather Bureau experts. What actually does happen is that strong upward currents of air sometimes hold raindrops up from underneath and prevent them from reaching the ground. In that case the drops gather in much larger quantities than they do normally. When the force of those ascending currents diminishes, or when so much water accumulates that the air can no longer support it, then there occurs the deluge of rain that is commonly called a cloudburst.

Mechanical Monitor Controls Machine Production



By cutting out much lost motion, the Chronolog to the left of the operator was instrumental in increasing output 62 per cent. The recorder is mounted on a machine turning out tire valve-stem caps in the plant of the National Acme Company of Cleveland, Ohio. Insert—Chronolog mounted on a standard alongside a machine.

KEEPING tab on machinery engaged in turning out all sorts of commodities is the work cut out for a new instrument called the Chronolog. This mechanical monitor lets nothing escape it, so it seems, for it is capable of recording, in minutes, the total elapsed time a machine is idle and productive during a run and of indicating the amount of work done in pieces, yards, or feet, as the case may be.

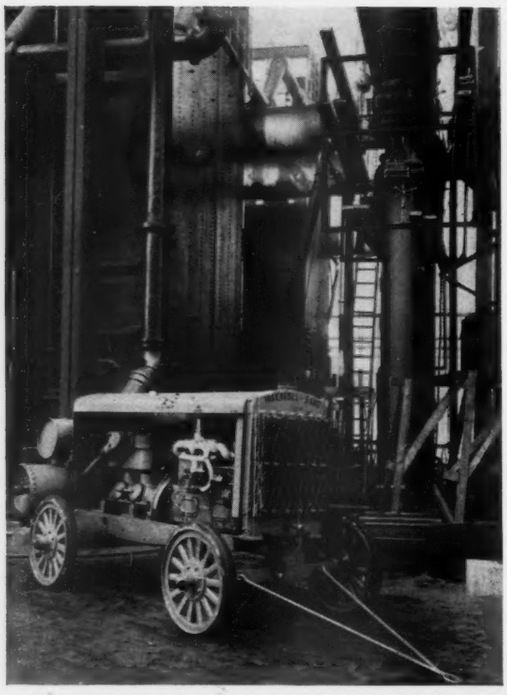
The Chronolog can be set up alongside a press, for example, and suitably connected, or, preferably, mounted on it so as to be in plain view and easy reach of the operator. A glance at the instrument, and he can check up on his machine, whether it is falling behind in production or keeping pace with it. In addition, it provides what is termed a Chronorecord which, when removed at the end of the day and totaled, gives the foreman or superintendent a detailed account of the output of the press, when interruptions occurred and why, and how long those interruptions held up operations.

The Chronolog is energized by the ordinary lighting circuit, and is started at the beginning of the working day by inserting a key in a slot and by throwing on the switch—the key remaining in place until the machine is shut down for the day. All these actions are automatically recorded to the minute. From the instant the press is in production, the instrument makes note of everything that happens—printing the hour at fixed intervals of 5, 10, 15, or 30 minutes to suit the particular requirements of the work that is being turned out.

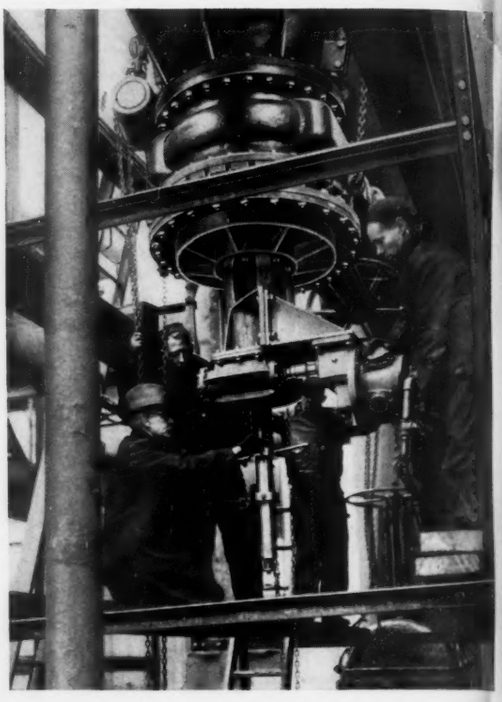
When the machine has to be stopped for any reason, the operator registers the fact by the use of a dial on the face of the Chronolog. On this dial are a series of letters, each of which stands for one of a list of causes—down for stock, inspection, cleaning, tool grinding, repair, no job, busy on other machine, set-up, etc.—which may be responsible for the temporary shutdown. The causes and corresponding letters of course vary with the type of machine in use. From that instant on the instrument adds up idle minutes instead of productive minutes, and continues to do so until the machine is again in running order and doing its accustomed work. The change is effected by a reset button which, when pressed, brings the dial back to letter "P", which stands for production. Should the operator fail to do this, the action of the machine in turning out the first piece will automatically attend to it for him, except when the dial is on "S", setting up. Pieces made during the set-up time are as a rule imperfect and, therefore, not counted. For that reason it is necessary to reset the Chronolog by dialing.

The instrument is being well received, it is said, by both managements and personnel—by the former because it gives them an accurate daily check on production and by the latter because it helps them to maintain their standard of output and therefore their earnings.

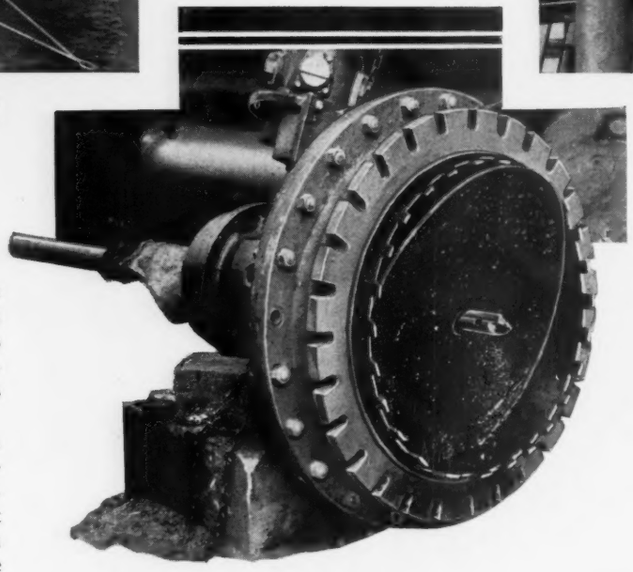
Elevated 42-inch Gas Main Tapped While in Service



The scene of operations and the portable air compressor utilized.



Close view of the work while underway 20 feet above the ground.



The tapping machine and the section of pipe removed by it.

AN UNUSUAL pipe-tapping operation was performed at Harrison, N. J., recently when workmen successfully cut a piece from a large, elevated, horizontal gas main without interrupting its service. The accompanying illustrations show the work in progress and the equipment that was used.

The line which was tapped is a 42-inch main at the plant of the Public Service Company of New Jersey. It connects the manufacturing plant with large gas holders, and through it passes the gas supply for a large section of Northern New Jersey. The purpose of the work was to permit the installation of an automatic valve on a by-pass line.

The section of pipe which was to be tapped was approximately 20 feet above the ground. The cut had to be made on its underside, which necessitated working upward from below. These difficulties were further complicated by the fact that after everything had been made ready and a day set for the work the weather turned bad, and the operations had to be carried on in the face of an extremely low temperature and a high wind.

The work was conducted by The A. P. Smith Manufacturing Company of East Orange, N. J., and was effected with the aid of one of that concern's special tapping machines. This mechanism was equipped with an Ingersoll-Rand stationary air motor. Compressed air was supplied by an I-R Type 20 portable air compressor.

Preliminary steps consisted of welding a steel hat-flange to the underside of the main at the exact place where the cut was to be made, and of permanently bolting a special tapping valve to it. This done, the tapping machine was hoisted into position directly beneath the valve, and then attached to it.

With the gate of the tapping valve fully open, the cutting apparatus of the machine was carefully advanced through the valve until it came in contact with the wall of the pipe. The cutting mechanism of the tapping machine is preceded by a relatively small center drill, the function of which is to provide an outboard bearing and a means of withdrawing the piece cut from the pipe.

It became a comparatively easy matter to rotate the cutting mechanism steadily and powerfully with the air motor, during which period its shaft was being gradually advanced by hand by an experienced operator. The actual cut was made in less than an hour. It was then necessary only to lower the cutting mechanism with the detached circular section below the gate of the valve, to close this gate so as to hold in the gas pressure, and, finally, to remove the tapping machine.

In addition to its effectiveness in furnishing the required power, compressed air proved well adapted to the work for two other reasons. Connection between the compressor and the air motor was easily maintained by flexible hose regardless of the position of the motor, whereas it would have been difficult to transmit power through a belt from a steam or gasoline engine on the ground. The use of compressed air also eliminated the hazard of fire or explosion which would have existed had some other form of power been utilized. It is seldom that large service pipes have to be tapped; but, when they do, it is evident from the foregoing description that such work can be accomplished quickly and successfully.